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ORIGINAL ARTICLE

Determining the utility and durability of medical equipment donated to a rural clinic in a low-income country

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Background: Health centers in low-income countries often depend on donations to provide appropriate diagnostic equipment. However, donations are sometimes made without an understanding of the recipient's needs, practical constraints or sustainability of supplies.

Methods: We donated a set of physical diagnostic equipment, non-invasive instrument tests and laboratory supplies to a rural health center in the Democratic Republic of Congo. We collected information on the usage and durability of equipment and supplies for each patient encounter over a 1-year period.

Results: We recorded 913 patient encounters. The most commonly used physical diagnostic equipment were the stethoscope (98.9%; 903/913), thermometer (81.7%; 746/913), adult scale (81.4%; 744/913), stop watch (62.6%; 572/913), adult sphygmomanometer (55.8%; 510/913), infant scale (24.9%; 228/913), measuring tape (24.3%; 222/913) and fetoscope (23.8%; 218/913). The most commonly used laboratory tests were the blood smear for malaria (53.7%; 491/913), hematocrit (23.5%; 215/913), urinalysis (20.1%; 184/913) and sputum stain for TB (13.3%; 122/913). With the exception of a penlight and solar lantern, all equipment remained functional.

Conclusions: This study adds valuable information about the utility and durability of equipment supplied to a health center in the Democratic Republic of Congo. Our results might aid in determining the appropriateness of donated medical equipment in similar settings. The selection of donated goods should be made with knowledge of the context in which it will be used, and utilization should be monitored.

Keywords: Delivery of healthcare, Developing countries, Diagnostic equipment, Rural health, World health

Introduction

Poor health outcomes in low-income countries (LICs) result from healthcare systems that lack infrastructure.[1–7] Some health facilities in resource-limited countries have trained personnel but lack appropriate equipment and supplies, thereby limiting their ability to provide medical care.[8,9] Because of lack of government support, these health centers are dependent on donated goods from international donors or foreign governments in order to provide or replace diagnostic equipment.[5,7,10]

WHO emphasizes that donated medical equipment should be directed to beneficiaries with a true need for the equipment, as well as the expertise and means to operate and maintain the equipment.[10] Currently, many donations consist of disposed old or unneeded equipment that recipients generally welcome to fill the gaps in their health centers, even if the supplies are not beneficial.[11] On average, 38% of medical equipment in developing countries is broken or out of service.[12] Although the majority of donations are given with honest intentions to strengthen the clinic or hospital, donors often overlook the deficiencies of infrastructure, such as lack of stable electricity and purified water of the receiving facilities.[12] The donations can be impractical substitutes for appropriate and sustainable technologies that are truly needed in these countries.

Most of the medical care in rural areas of the Democratic Republic of Congo (DRC) is delivered in health centers, and these centers typically lack basic infrastructure and equipment. Much donated equipment goes unused because the appropriate

diagnostic equipment needs are yet to be clearly defined. The purpose of this project was to evaluate the utilization and durability of a set of healthcare equipment and supplies provided to a rural health clinic in the DRC. The study was designed to simulate current practice, in which equipment is donated without instruction or training on the use of the equipment. The aim of this study was to determine the utility and durability of a variety of diagnostic instruments and equipment.

Materials and methods

We assembled a set of equipment and supplies to be donated based on the knowledge and experiences of a focus group of Congolese physicians working in the local health region and physicians in the author group from the United States who spend a portion of their time in the DRC. Physicians were interviewed to identify local deficiencies in the provision of adequate healthcare. We identified a list of affordable, rugged equipment to provide basic laboratory services and physical examinations without the need for wall power. All equipment was packed in a container that complied with the regulation limits for checked baggage on international flights (maximum weight of 23 kilograms and not exceeding 62 inches); total cost of the equipment provided was less than US$1300. Because importation of goods is difficult in the DRC, we designed all equipment to comply with the regulations for checked baggage, as this is a common way that medical supplies are delivered to this region. We provided minimal training in the use of equipment or diagnostic tests, in order to simulate the process that most donors follow.

Setting

Takaya Health Center is located in the rural Equateur Province in the northern part of the DRC and is the primary location of medical care for the 7400 residents in the surrounding communities. The clinic consists of five rooms including an examination and treatment room, a labor and delivery room, a pharmacy and two laboratory rooms. There is no electricity in the clinic and water is supplied from a rooftop cistern. Two nurses, a laboratory technician and an administrator, who also runs the pharmacy, staff the clinic without direct supervision of a physician. The nearest hospital is 40 kilometers away. The clinic receives funds primarily from the Catholic mission and supplemental funds from the Covenant Church of Congo and the Congolese government.

Physical diagnostic equipment

We supplied the health center with physical diagnostic equipment including: two stethoscopes (Proscope, ADC, Hauppauge, NY, USA); an otoscope (MABIS PICCOLIGHT, Briggs Healthcare, Waukegan, IL, USA); a Snellen-Type Plastic Eye Chart (Grafco, Graham-Field Health Products, Inc., Atlanta, GA, USA)**;** a pen light (Emergency Medical International, Lily Lake, IL, USA); a digital thermometer (Adtemp, ADC, Hauppauge, NY, USA); a digital infant scale (Narang Medical LTD, New Delhi, India); a digital adult scale (Healthometer, Sunbeam, Boca Raton, FL, USA); a mid-upper arm circumference (MUAC) band (Médecins Sans Frontières); an adult-sized sphygmomanometer cuff (ADC, Hauppauge, NY, USA); a pediatric-sized sphygmomanometer cuff (MABIS, Briggs Healthcare, Waukegan, IL, USA); measuring tape (Graham-Field Health Products, Inc., Atlanta, GA, USA); two stopwatches and a fetoscope.

Non-invasive instrument testing

We supplied a fingertip pulse oximeter (MEDQUIP, Bluffton, SC, USA) and a glucometer with 50 test strips.

Laboratory capabilities upgrades

We supplied laboratory equipment including: a battery-powered Global Focus fluorescence microscope with light source (Rice University, Houston, TX, USA);[13] a hand-powered centrifuge (Rice University);[14] microscope slides and coverslips; Giemsa stain, acid fast stain, Wright's and gram staining supplies; immersion oil; dropper bottles; a plastic funnel; a permanent marker; a sharps container and a manual hemocytometer (Spectrum Scientifics, Philadelphia, PA, USA). We also supplied a solar-powered lantern (SolaDyne, Aervoe Industries, Gardnerville, NV, USA), rechargeable batteries (SANYO eneloop, Panasonic, San Diego, CA, USA) and a solar-powered recharging system (PowerFilm, Ames, IA, USA) for all equipment that required an auxiliary power source.

Data collection and analysis

For each patient encounter during 2012, exclusive of pregnant women who presented for delivery, the health center nurse recorded patient demographics, including sex, age and chief presenting complaints on a data form at the time of the visit (Supplementary data). The nurse also recorded which pieces of equipment were used at each patient encounter on a data form. Quarterly, we collected information on the durability of the provided instruments based on the health center staff's impression if the equipment still functioned.

We conducted univariate descriptive analysis of patient characteristics, chief complaints and determined frequencies of the use of each type of equipment or supply. We used descriptive data to determine the longevity and durability of selected pieces of equipment.

Results

We collected information from 913 patient encounters during the study period (Table 1). The stethoscope, thermometer, adult scale, stopwatch and adult sphygmomanometer were used in more than half of the patient encounters (Table 2). Three pieces of equipment were used during approximately one-quarter of patient visits: the infant scale, measuring tape and the fetoscope. Several diagnostic equipment items were used in less than 1% of the patient encounters: the eye chart (6/913), the pediatric sphygmomanometer (5/913), the penlight (2/913), the otoscope (1/913) and the MUAC band (1/913).

The non-invasive instrument tests (glucometer and pulse oximeter) were used in 1% (13/913 and 9/913, respectively) of encounters (Table 2). The most commonly used laboratory tests were the blood smear for malaria, hematocrit, urinalysis and sputum stain for tuberculosis (Table 2). A complete blood count and sputum stain for bacteria were performed in 1.8% (16/913) and 0.1% (1/913) of encounters, respectively. The Global Focus fluorescence microscope was unused.

Table 1. Description of patient encounters at Takaya Health Center in the Democratic Republic of Congo

Patient encounters	Total=913 n (%)
Male patients	360 (39.4)
Age of patients	
≤5 years	355 (38.8)
>5 years	558 (61.1)
Chief complaint	
Fever	351 (38.4)
Headache	188 (20.5)
Vomiting	174 (19.1)
Diarrhea	114 (12.4)
Other	611 (66.9)

Table 2. Utilization of medical equipment and supplies at Takaya Health Center in the Democratic Republic of Congo

		Number of uses (% of encounters)
Physical diagnostic equipment	Stethoscope	903 (98.9)
	Thermometer	746 (81.7)
	Adult scale	744 (81.4)
	Stop watch	572 (62.6)
	Adult sphygmomanometer	510 (55.8)
	Infant scale	228 (24.9)
	Measuring tape	222 (24.3)
	Fetoscope	218 (23.8)
	Eye chart	6 (0.7)
	Pediatric sphygmomanometer	5 (0.5)
	Pen light	2 (0.2)
	Otoscope	1 (0.1)
	MUAC band	1 (0.1)
Non-invasive instrument tests	Glucometer	13 (1.4)
	Pulse oximeter	9 (0.9)
Laboratory tests	Malaria smear	491 (53.7)
	Hematocrit	205 (22.4)
	Urinalysis	184 (20.1)
	Sputum stain for tuberculosis	122 (13.3)
	Complete blood count	16 (1.7)
	Sputum stain for bacteria	1 (0.1)

MUAC: mid upper arm circumference.

Nearly all of the donated equipment and supplies were available and functional for the entirety of the assessment period. A solar lantern and a penlight were broken early in the year. The lantern was replaced with a more durable model.

Some supplies were depleted during the year, and were replaced by the health center, including the batteries and ethanol. After 8 months, another donor replaced the microscope slides and cover slips. After 11 months, the supply of capillary tubes for the centrifuge was exhausted and not replaced, making the hand-powered centrifuge unusable. Urine test strips were used within 8 months and not replaced during the study period. Glucometer test strips were depleted after 9 months and replacements could not be obtained locally.

Discussion

In this study we evaluated the utilization and durability of a set of healthcare equipment and supplies donated without training to a rural health center in the DRC. Among the donated equipment, we identified equipment that was frequently used and equipment that was infrequently used in typical patient encounters in this region. We observed patterns of use of physical diagnostic equipment. For example, the five most commonly utilized physical diagnostic equipment items (stethoscope, thermometer, adult scale, stop watch and adult sphygmomanometer) were pieces of equipment typically used in obtaining vital signs. The next most frequently used pieces of equipment (infant scale, measuring tape and fetoscope) were designed for obtaining vital signs in special populations, such as pediatric patients and pregnant women. Because nurses staff the health center, we speculate that the previous training of the healthcare provider determined the frequency of use of the physical diagnostic equipment.

Laboratory testing appeared to be driven by disease prevalence in the community, the ability to treat the diagnosed disease and the knowledge of the staff using the equipment. We observed high use of diagnostic laboratory tests that reflected the high prevalence of diseases in the surrounding community. In the DRC, the adult mortality from malaria is 60 per 100 000 and from TB is 54 per 100 000.[15] Because of the baseline high prevalence of these diseases, tests for these diseases are commonly performed. However, although diseases that alter blood sugar or oxygen saturation are prevalent, these diagnostic tests were infrequently used. In this health center, there are limited resources to treat patients who have such underlying diseases, for example, oxygen is not available in this health center or any health center or hospital in the surrounding region. We speculate that lack of treatment for these disorders was a disincentive to use the appropriate diagnostic tools.

The least commonly used laboratory tests, such as blood counts and sputum stains require additional training to perform accurately. We speculate that the staff might have used these supplies and equipment more frequently if appropriate training had been conducted prior to their donation to the clinic. One piece of equipment in particular, the solar-powered microscope, was not used. The local technician preferred to use the older, light-reflecting microscope with less desirable optical capabilities. This might have occurred because of lack of understanding about the operation of this device. We speculate that the staff might have used these supplies and equipment more frequently if appropriate training had been conducted prior to their donation to the clinic.

An important aspect of this study was the determination of the durability of the donated equipment. Although much of the

equipment was still usable after the 1-year observation period, we found some supplies that were inconsistently replaced. We speculate that the perceived usefulness of the supplies, the cost of replacement, the availability of funds and the local accessibility of those supplies were important determinants in the replenishment of supplies. Items that can be routinely used and readily available in the United States were not easily replaced in the rural setting of the DRC.

Because this study focused on the utilization of equipment and supplies, we did not assess health outcomes. Previous research has shown that deficient infrastructure and limited resources in LICs result in substandard healthcare and poor health outcomes,[4–7] and have acknowledged the ineffectiveness of most donation processes.[1,11,12] We presume that better diagnostic equipment might improve patient diagnosis over time and direct limited resources for treatment toward patients with accurate diagnoses who are likely to receive the most benefit from these therapies. This hypothesis should be tested in future studies.

This study is an important first step in determining the appropriateness of donated medical equipment in a resource-poor setting; however, we recognize some limitations in the study. The health center that was chosen for this study is a high functioning clinic with well-trained personnel and more resources than many other health centers in the DRC. Therefore, our results might not accurately represent all health centers in this rural area. We recognize that our results were dependent upon factors unique to the health center and the health infrastructure in rural DRC.

Conclusions

Because this health center and the healthcare infrastructure in the DRC share similar impediments to health delivery as other health centers in many LICs dependent on foreign aid, we believe that several conclusions are justified. Our findings suggest that local healthcare providers utilize equipment with which they are familiar. Therefore, donations of medical equipment and supplies should be made in collaboration with local providers to determine the level of training of the end-user of the donated equipment. We found medical supplies that were utilized or exhausted and not replaced, and conclude that monitoring of the utility of equipment and the availability of supplies should follow donations and should guide future giving. Finally, we speculate that education regarding the use and maintenance of more complex pieces of equipment would have increased their usefulness and should be provided when these donations are made.

Supplementary data

Supplementary data are available at International Health Online (http://inthealth.oxfordjournals.org/).

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Author's contributions: CB, RRK and JG conceived the study; CB, RRK, JW, JG, AL and AT designed the study protocol; JG, AL and AT carried out the assessment; MB and CH analyzed and interpreted the data; MB, CH, CB drafted the manuscript; MB, RRK and CB critically revised the manuscript for intellectual content. All authors read and approved the final manuscript. MB and CB are guarantors of the paper.

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