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Cost-Effectiveness of Screening and Treatment for Cervical Cancer in Tanzania: Implications for other Sub-Saharan African Countries

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ABSTRACT

Objectives: To compare the institutional cost per person of screening and treatment between two groups of patients—those screened and those not screened before treatment for cervical cancer at Ocean Road Cancer Institute (ORCI) in Dar es Salaam, Tanzania—and to perform a cost-effectiveness analysis of the ORCI cervical cancer screening program. **Methods:** The study included 721 screened and 333 unscreened patients treated at ORCI for cervical cancer from 2002 to 2011. We compared the cost of cervical cancer treatment per patient with life-years gained for patients screened at ORCI versus not screened. **Results:** Patients with cancer were diagnosed at an earlier stage after participating in screening compared with nonparticipants. For example, 14.0% of stage I cancer patients had received screening by ORCI compared with 7.8% of unscreened cases. For stage IV cancer, these percentages were 1.4% and 6.9%, respectively. Average screening and treatment cost for patients receiving cancer screening (\$2526) was higher than that for unscreened patients (\$2482). However, we

calculated an incremental cost-effectiveness ratio of \$219 per life-year gained from receiving cervical cancer screening compared with not being screened, and thus the ORCI screening program was highly cost-effective. Furthermore, the screening program was associated with averting 1.3 deaths from cervical cancer each year resulting from earlier diagnoses of cancer cases, with the incremental cost-effectiveness ratio of \$4597 per life saved. **Conclusions:** Although Sub-Saharan Africa faces substantial challenges in population health management, our study highlights the potential benefits from expanding access to regular cervical cancer screening for women in this region.

Keywords: cancer screening, cancer treatment, cervical cancer, cost-effectiveness, institutional cost, Tanzania, sub-saharan Africa.

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Introduction

Each year, there are 500,000 cases and 230,000 deaths caused by cervical cancer worldwide [1]. Eighty-five percent of these cases are in developing countries [2]. Although cervical cancer is often detected early and treated successfully in the United States, the health care system in Tanzania faces substantial challenges in providing regular screening and treatment of cervical cancer [3]. In fact, Sub-Saharan Africa has the highest incidence of cervical cancer in the world, with an incidence rate of 50.9 cases per 100,000 women, and cervical cancer is the most common cause of death from cancer for women in Tanzania [3,4].

Ocean Road Cancer Institute (ORCI) in Dar es Salaam is the only specialized cancer treatment hospital in Tanzania. More than one-third of the cancer patients seen at ORCI are diagnosed with cervical cancer [3]. ORCI has a national network of clinics

performing visual inspection with acetic acid (VIA) screenings by trained health care professionals [5,6]. VIA screenings have been found to be a lower resource alternative to effectively screen for cervical cancer, compared with cytology-based screening [6]. Unfortunately, access to screening services is limited, with only 12 of 21 regions in Tanzania having these screening clinics [7]. Furthermore, most screening clinics are in urban areas although 75% of the population lives in rural areas [2]. In Tanzania, only 1 in 20 women aged 30 to 50 years old ever receive cervical cancer screening, and consequently many women consult a health care provider only after developing late-stage cervical cancer [5,8–10].

Cancer screening, treatment, and care are provided at no cost to patients by the government of Tanzania [3]. However, the cost-effectiveness of providing cervical cancer screening is unclear. With limited resources being available in Tanzania, this is an important issue for continued funding and expansion of access to

Conflict of interest: The authors have indicated that they have no conflicts of interest with regard to the content of this article.

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<http://dx.doi.org/10.1016/j.vhri.2016.03.002>

these services. Our study uses detailed cost and outcomes data on ORCI patients to examine the cost-effectiveness of cervical cancer screening services compared with status quo.

Methods

Patient Population

The study population included 721 screened patients (seen at the ORCI screening clinic) and 333 unscreened patients who visited the ORCI treatment clinic with no previous screenings at ORCI. Screened patients included those receiving at least one cervical cancer screening before being diagnosed with cancer. Both groups were treated for cervical cancer at ORCI during the period 2002 to 2011. Of the screened patients, 14.0% were clinically diagnosed as having stage I cancer, 48.4% as having stage II cancer, 36.2% as having stage III cancer, and 1.4% as having stage IV cancer. Of the previously unscreened cancer patients, 7.8% were having stage I cancer, 51.1% were having stage II cancer, 34.2% were having stage III cancer, and 6.9% were having stage IV cancer.

Cost Estimates

All costs collected were institutional costs provided by ORCI. Cervical cancer screening costs include the cost of supplies per patient for VIA and the salaries of nurses and physicians performing the screening. The cost of supplies included the cost of cleaning materials, forceps, and reagents including acetic acid, examination gloves, cotton swabs, and other supplies. Relevant supplies and their costs were identified on the basis of interviews with health professionals of ORCI and review of the 2013 Medical Stores Department Catalogue of ORCI. Cryotherapy cost was calculated by adding medical personnel cost (salaries and wages with length of staff time allocated to cryotherapy) and cost of supplies and equipment for cryotherapy. Costs of supplies and equipment were retrieved from the ORCI Medical Services Price List.

Treatment cost included labor, the supplies and services used for treatment, and patient hospital accommodation/admission. The services used for treatment were identified through 10 interviews with ORCI medical personnel including three physicians, one X-ray technician, one radiography technician, two nurses in the screening clinic, the hospital head nurse, and two laboratory technicians. The interviews were conducted in person in July 2014. They were semi-structured interviews, including six questions and observations of the health care workers with their patients. The typical questions were as follows: 1) How many cervical cancer patients do you see each day? 2) How long do you spend on average with each cervical cancer patient? 3) How much do each of the machines/medications/treatments cost that you use for cervical cancer patients? 4) Can you walk me through a typical session with a cervical cancer patient? 5) How do your sessions differ depending on the cancer stage of the cervical cancer patient? 6) Does the treatment plan set up differently depending on patients' diagnosis information before screening? Depending on who was being interviewed, there were sometimes follow-up questions. If the interviewee was unaware of cost information, this question was taken to the accounting department. Each interview lasted approximately 1 hour. This information included treatment resources used to manage patients stratified by stage of cervical cancer diagnosis and included initial examination, cancer treatments, and follow-up care. The cost of these services was retrieved from the ORCI Medical Services Price List. Cost for supplies not found in the price list was obtained from the 2013 Medical Stores Department Catalogue.

Salary information for staff was provided by the ORCI accounting department. Consultation time per patient was determined in interviews with physicians and a review of 179 patient records from 2007 to 2011. Using these data, we calculated the average monetary cost of staff time allocated to treatment.

The model analyzed cost from the institutional perspective. Thus, only direct costs were included in the analysis, such as screening, treatment, and accommodation costs, which are funded by the government of Tanzania. Screening program costs were compiled in consultation with the head nurse of the cervical cancer screening center (Table 1). The cost of treatment for cervical cancer was derived from historical data, interviews, and patient records, as described above. The per-person cost was obtained by calculating the average of the cost of all patients treated from 2002 to 2011. Stage I and stage II patients received curative treatment and stage III and stage IV patients received palliative treatment. All cost was converted from Tanzanian shillings to US dollars (US \$1 = 1706 Tanzanian shillings) using the currency exchange rate at the time of this study.

Outcome Estimates

The probability distribution of cancer stage was found on the basis of previous research reporting the likelihood of cervical cancer diagnosis and staging for Tanzanian women in the period 2002 to 2011 [11]. Because cervical cancer survival probability has not yet been evaluated in Tanzania, we used estimates from a South African study that estimated average 5-year survival [12].

The primary health measure used in our study is the number of life-years gained. Undiscounted life-years were calculated as follows:

$$\begin{aligned} \text{(Undiscounted) Life-years} &= \text{Survival probability} \\ &\times (\text{Tanzanian life expectancy} - \text{Average} \\ &\text{age of diagnosis for cervical cancer patients}) \\ &+ (1 - \text{Survival probability}) \times 2.5 \end{aligned}$$

The expected number of remaining life-years was based on Tanzanian life expectancy of 62.6 years in 2014 for females [13]. Life-years were also discounted by 3% each year following previous literature. Discounted life-years were then aggregated to determine total life-years per person and total life-years for

Table 1 – Average screening variables per patient for cervical cancer at ORCI from 2002 to 2011.

Variable	Value
Number of patients seen each day	25
Time to perform VIA screening	10 min
Labor per person	
Daily salary for medical personnel	US \$49.86
Staff time per woman to perform cryotherapy procedure	10 min
Cost of supplies	
Per patient cost of supplies for VIA	US \$0.41
Per patient cost of supplies and equipment for cryotherapy	US \$26.37
Total screening cost	US \$1.45
Total cryotherapy cost	US \$28.97

Note. US \$1=1706 Tanzanian shillings.

ORCI, Ocean Road Cancer Institute; VIA, visual inspection with acetic acid.

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