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Measurement and evaluation of digital cervicography programs in two cervical cancer screening camps in East Africa

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ABSTRACT

Cervical cancer disproportionately affects women living in low- and middle-income countries. To address this global crisis, many governments and NGOs have implemented community-based screening and treatment programs at outreach camps. Here, high volumes of patients are able to access care: screening and diagnosis followed by immediate treatment of precancerous lesions onsite. However, monitoring and evaluation (M&E) of these efforts presents challenges, since each event typically relies on a different health workforce, and refers patients to different facilities for follow up and advanced care. To address these challenges, a digital imaging intervention was deployed at several screening camps in East Africa. Trained nurses screened women using a connected low-cost mobile colposcope built around a smartphone. A decision support job aid was integrated into the app controlling the device, guiding nurses and recording their diagnosis and treatment decisions. Aggregating the data from the job aid allowed M&E of the screening camp in real-time. In this paper, the M&E data from 2 different screening camps in East Africa are compared. Additionally, screening camps are compared to stationary clinics. Differences in the patient screening times, treatment rates, and individual nurse statistics were all documented through the job aid allowing for much improved epidemiological information following outreach events thus enabling targeted program improvements and provider training. Reporting data from screening camps were also shared online via public web pages, facilitating broader dissemination of health needs in specific East African communities, and sparking conversations with regional stakeholders about local disease burden.

Keywords: Low resource settings, colposcopy, translational research, imaging

1. INTRODUCTION

Cervical cancer kills 266,000 women a year, 85% of these are in the developing world[1]. To defeat cervical cancer 1.2 billion screenings per year need to be performed. In resource-limited settings, the standard method of screening is visual assessment with acetic acid (VIA) where the aceto-whitening of cervical tissue after applying acetic acid is visualized with the naked eye. Screen and treat programs have been demonstrated effective and practical in resource limited settings[2], and some prior works exists on successfully using digital imaging of the cervix to aid in VIA[3].

In previous work we introduced a low-cost mobile phone based colposcope[4]. This system has been refined and commercialized as the Enhanced Visual Assessment (EVA) System[5]. More than 200 EVA Systems are being used to perform cervical screening in over 20 countries. The EVA System consists of mobile phone, a lens, a light source and an enclosure (Fig. 1). The EVA System has augments VIA procedures in two main ways. On the hardware side, it provides magnification and a consistent light source for visualization, while the software allows for real time workflow support and procedure logging for monitoring and evaluation (M&E). The EVA System was designed for use by both nurses and physicians, who carry out most of the VIA screening procedures worldwide[5].

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Fig 1. The MobileODT enhanced visual assessment system (Mobile Colposcope)

In this paper, we present results from one particular feature of interest to many VIA programs – a job aid that documents the diagnosis and treatment decisions of the nurse that conducted VIA screening. The job aid is a software feature that guides provider workflow and records data automatically. This feature was designed to improve M&E in existing VIA programs. We have tested the implementation of the novel job aid feature on the mobile colposcope app during several deployments of the EVA System in several sites in East Africa. We show that the integration of this feature allows for improved M&E of VIA programs by providing key statistics. These statistics can be used to guide operational and policy decision making by non-governmental organizations, as well as governments and public health officials.

2. METHODS

2.A. Clinical sites

Data presented in this paper was compiled from various organizations running VIA programs in east Africa. All organizational detail has been anonymized prior to analysis. Cervical cancer clinics were categorized as either being stationary clinics that tend to operate in big cities, and also as screening camps that are part of outreach efforts to reach more rural and remote locations. Data from both types of clinics were analyzed and compared.

2.B. Clinical workflow

To begin a VIA procedure, a speculum is inserted into the vagina to open up the vaginal canal and enable visualization of the cervix. Acetic acid is applied to the cervix using an elongated swab, which removes moisture from the cells and turns areas with cervical dysplasia white over approximately 2 min. The cervix is illuminated from outside the patient's body and visualized by the clinician. If the clinician observes white area(s) on the cervix, the test result is considered positive. The clinical workflow in VIA procedures augmented by EVA (Fig. 2) is nearly identical, except that the cervix is visualized using the mobile colposcope that is placed 10–15 cm from outside the vulva. Two minutes after the application of acetic acid, the clinician (nurse) visualizes and records images of the cervix using the mobile colposcope. Following the exam, the nurse shows the patient an image of her cervix, records a clinical decision, and instructs the patient accordingly. Both mages and decisions are uploaded to a secure, web-based image portal.

2.C. Decision support job aid

The key feature that provided the data presented in this paper is the decision support job aid[5] (Fig. 2), which was integrated into the EVA System mobile application and used by the nurses to document their clinical decisions. The job aid was designed to account for various clinical results from VIA procedures: Normal/abnormal cervix, where abnormal results are further categorized as pre-cancerous lesion, suspected cancer, cervicitis, or other. Treatment options and referrals were also included. Results of the diagnosis and treatment decisions were uploaded onto the web-based image portal and

compiled. Statistics on the number of patients screened, clinical findings, and treatments were calculated and compared across multiple organizations.

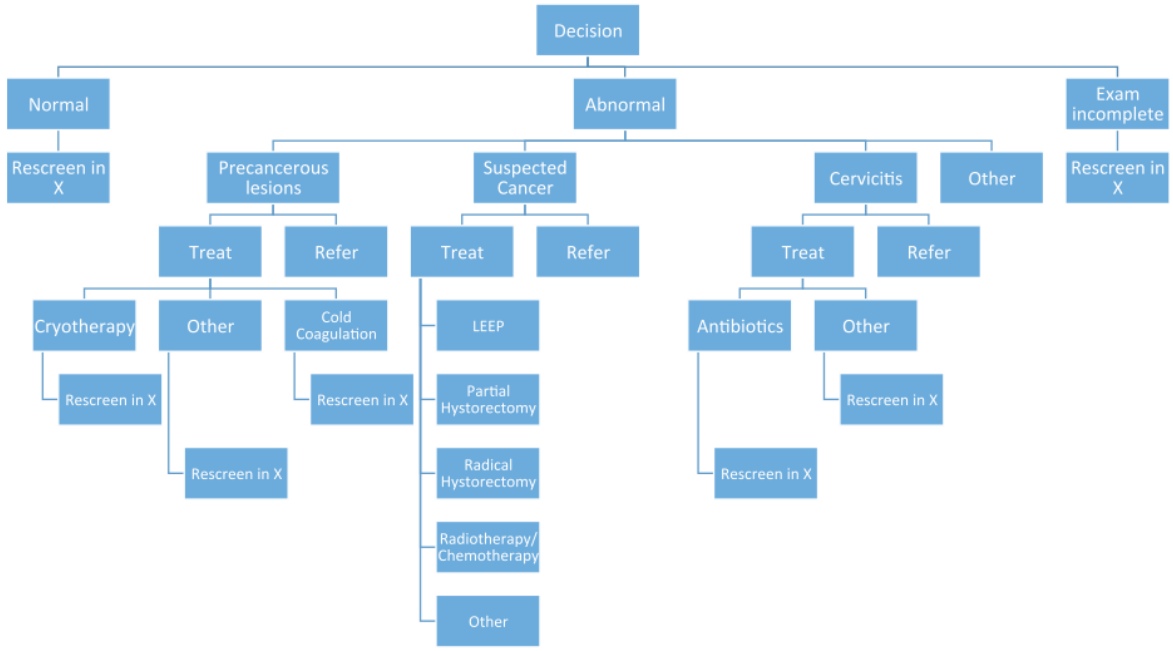

Fig. 2: Decision tree representation of the options in the decision support job aid used following imaging of each patient. The user is guided by the CervDx app on the mobile colposcope.

3. RESULTS AND DISCUSSION

General statistics from 2 screening camps is presented in Fig. 3A-B; the 2 camps were 100 km apart. It can be seen that the rates of both precancerous lesions and cervical cancer are markedly different. Specifically, the rate of screening camp 2 (Fig. 3B) had a substantially lower rate of cervical dysplasia than screening camp 1 (Fig. 3A), while at the same time, screening camp 2 had a much higher rate of cancer. Because dysplasia can be treated on the spot with cryoablation, and cervical cancer patients need to be referred to higher level facility for care, information on the number of patients with different diagnoses is useful in order to make operational and policy decisions.

Generally speaking, screening camp 1 was more in line with the expected prevalence of cervical dysplasia and cancer of 10% and 1%, respectively, while screening camp 2 deviated substantially[1]. In trying to analyze the reasons for this, it is worth considering that these analyses are based on nurse-provided annotations, which varies considerably across VIA clinics in Africa[3]. Therefore, it is possible that nurse training, or lack thereof, added noise to the data presented here. A more robust analysis will require review by an outside expert to verify the nurses diagnosed the patients correctly. Such quality assurance measures are currently being developed and tested.

A second comparison compares screening camps to stationary clinics (Fig. 4) in terms of patients seen, total number of cryotherapy procedures administered, as well as rates of cervical dysplasia and cancer. It can be seen that the rates of dysplasia and cancer differed substantially between the 2 types of clinics. The rates of both dysplasia and cancer were substantially higher in the stationary clinic than in the screening camp. Those rates were also higher than the expected rates for low resource settings[1]. In terms of cryotherapy procedures, the total rate recorded by the stationary clinic was similar to the dysplasia rate. However, the number of cryotherapy procedures was much lower than the expected values[1]. Digging deeper into the numbers, it becomes apparent that cases of cervicitis were conflated with cancer in the stationary clinic, which did not record any cervicitis at all (data not shown). This suggests that the data reflects more practitioner

behavior rather than reflect rates of cervical dysplasia / cancer in the general population. Furthermore, better training is needed to ensure nurses who diagnose patients are making the correct decision.

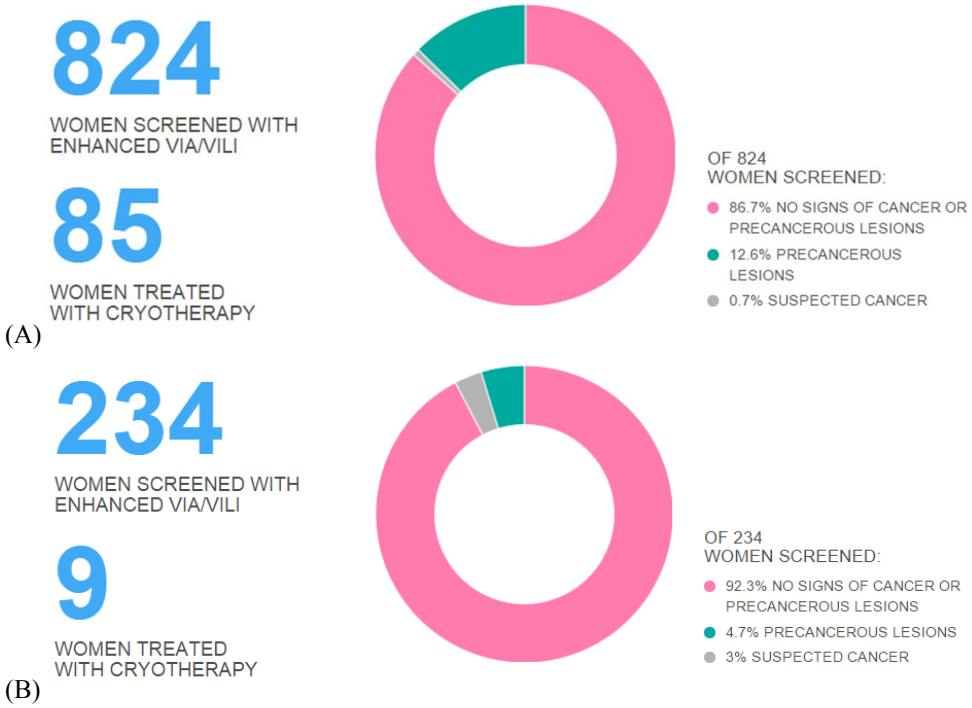

Fig. 3: Basic statistics from 2 screening camps on patients, and positive diagnoses for both dysplasia and cancer.

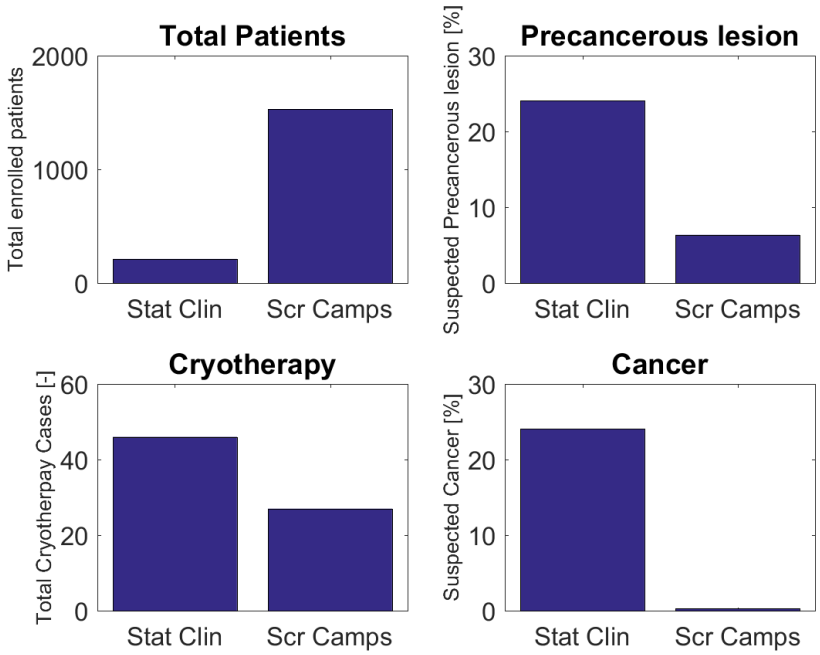

Fig. 4: Basic statistics comparing stationary clinics and screening camps. Parameters recorded include total patient number, total cryotherapy procedures, and rates of dysplasia and cancer.

4. CONCLUSION

The data presented here represents a snapshot of clinical practices in cervical cancer clinics in east Africa. To our knowledge, no similar database exists to which we can compare our results. Additional test results that enable a deeper analysis of clinical behavior is currently underway.

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REFERENCES

[1] Globocan.iarc.fr, "Fact Sheets by Cancer", 2016. [Online]. Available: http://globocan.iarc.fr/Pages/fact_sheets_cancer.aspx. [Accessed: 24- Feb- 2016].
[2] L Denny, L Kuhn, M De Souza, AE Pollack, W Dupree, TC Wright. "Screen-and-treat approaches for cervical cancer prevention in low-resource settings: a randomized controlled trial". *J AMA*, **294**, 2173-2181 (2005).
[3] Parham, G. P., Mwanahamuntu, M. H., Pfaendler, K. S., Sahasrabuddhe, V. V., Myung, D., Mkumba, G., Kapambwe, S., Mwanza, B., Chibwesha, C., Hicks M. L., Stringer, J. S. A. "eC3—a modern telecommunications matrix for cervical cancer prevention in Zambia". *J Low Gen Tr Dis* **14**, 167-173 (2010)
[4] Kass, A. J., Slyper, R., Levitz, D., "Optical design of low cost imaging systems for mobile medical applications" in Optics and Biophotonics for Low-Resource Settings. *Proc SPIE* **9314**, 93140B (2015).
[5] C Peterson, D Rose, J Mink, and D Levitz, "Real-Time Monitoring and Evaluation of a Visual-Based Cervical Cancer Screening Program Using a Clinical Decision Tree Algorithm". Submitted to *Diagnostics* (2016).