

## Use of Mobile Telemedicine for Cervical Cancer Screening in Gaborone, Botswana

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**Introduction/Aims:** Mobile telemedicine is a nascent field that allows medical consultations to be submitted via mobile phone, without the need for a computer or Internet access. This technique allows health care to reach rural areas of the developing world, where cell phone coverage extends beyond computer networks. Throughout the developing world, delivery of women's health care, specifically cervical cancer screening services, is limited by cost, infrastructure, and available clinicians and cytologists. Visual inspection with application of 4% acetic acid (VIA) is a practical, inexpensive alternative to cytology-based screening. As a visually-based screening modality, VIA is amenable to mobile telemedicine in areas where women's health resources are limited, but mobile phone infrastructure is extensive.

We will present preliminary results of a CFAR-sponsored study evaluating the use of mobile telemedicine for the diagnosis and/or triage of cervical pre-cancer/cancerous lesions in HIV infected patients in Botswana. The primary aim of this study is to evaluate the accuracy and safety of remote diagnosis and/or triage by physicians using photographic images of the cervix after application of acetic acid transmitted via a mobile telemedicine. We plan to accomplish this aim through a prospective case control study involving women presenting to Bontleng Clinic in Gaborone, Botswana for routine cervical cancer screening.

**Methods & Design:** ClickDiagnostics has developed software (ClickDoc) specifically for remote diagnosis with the Samsung Soul U900 phone, which comes equipped with a 5 Megapixel camera. The software and phone have been tested in both a proof of concept study in Egypt, as well as preliminarily testing demonstrating successful end-to-end transmission of diagnostic photos from Gaborone, Botswana, to the University of Pennsylvania, USA.

In our prospective case control study, 95 women presenting to Bontleng Clinic in Gaborone were enrolled and had:

1. VIA evaluation by an onsite clinician
2. an HPV sample taken
3. cervical photos taken with the Samsung Soul U900 phone 5 Megapixel camera
4. photos evaluated by original onsite clinician and remote gynecology specialist blinded to the initial visit

VIA and PIA results were categorized as "positive," "negative," or "indeterminate." Percent agreement including 95% confidence intervals will be calculated for each pair of diagnostic impressions: 1) off-site gynecologist based on PIA to on-site clinician using VIA; 2) on-site clinician using PIA to on-site gynecologist using VIA; 3) off-site gynecologist based on PIA to on-site clinician using PIA. Comparisons of percentages of positive vs. negative will be performed using the McNemar's test. The kappa statistic will be used to measure reproducibility between PIA and VIA. Sensitivity and specificity characteristics along with 95% confidence intervals for the PIA in comparison to VIA will be determined, along with positive and negative predictive values for the PIA.

**Results:** Final data analysis is currently underway and preliminary results will be presented. We hypothesize that there will be significant concordance in the diagnosis of cervical lesions in HIV patients, when comparing the diagnosis of the on-site clinician to the diagnosis of the clinician evaluating the photos through telemedicine. We base this hypothesis on a proof of concept study that has been completed in Egypt. In a series of 30 dermatologic patients, each evaluated using the Samsung Soul U900 phone and ClicDoc data collection, concordance in diagnosis between the onsite and remote specialists was achieved in 23 out of 30 cases. Reason for non-concordance was primarily that the history received by the off-site doctor was deemed insufficient.

**Technical & Feasibility Constraints:** While proof of concept results have been promising, these studies evaluated use of telemedicine for diagnosis of skin lesions. Photographing the cervix with the Samsung Soul U900 phone 5 Megapixel camera has proved more difficult than photographing skin lesions due to challenges in attaining adequate and consistent lighting of the cervix within the vaginal canal. At Bontleng Clinic, women are already having photographs of their cervix taken as part of routine care using a high quality digital camera. By using the same halogen floor lamp used in exams and these photos, with careful positioning, adequate lighting for photography with the Samsung Soul U900 phone can be achieved. The technique for photographing with phone is simple, reproducible, and has now been successfully taught to all four nurse midwives working at Bontleng Clinic. There are minimal cultural barriers to taking photos of the cervix at clinic because all patients presenting to Bontleng Clinic are consenting to and having photographs taken as part of routine clinical care.

**Conclusions:** Women in sub-Saharan Africa often present with advanced cervical cancer, even though precancerous lesions are detectable via cervical screening techniques. This is the result of multiple factors, including lack of screening, lack of appropriate referral, as well as HIV-HPV (human papillomavirus) co-infection. In order to improve the availability of cervical cancer screening in Botswana, we propose the use of mobile telemedicine as an adjunct tool to visual screening techniques for cervical cancer. We aim to show that mobile telemedicine technology is a reliable method for diagnosing cervical lesions compared to in-person gynecological evaluation. Use of this technology has the potential to connect resource-poor cancer screening centers to remotely-located

gynecologists who can diagnose lesions and direct appropriate therapy, which will help to prevent cervical cancer in Sub-Saharan Africa.

**Future Directions, Deployment & Scaling Up:** From the results of these three initial studies, we hope to design even larger studies to more thoroughly evaluate the use of this technology for diagnosis, treatment advice, and referral recommendations in rural clinics throughout Botswana and other African countries. We also intend to expand the service to other visual specialties, including radiology and ophthalmology. It is our hope that by creating a mobile telemedicine network throughout Africa, we can facilitate the effective diagnosis, appropriate referral, and proper treatment of cervical dysplasia and cancer in patients living in rural Africa with otherwise limited access to care.