

affecting this study, the lack of complete record keeping may be affecting quality of care because of the inability to follow a mother throughout labor and delivery. For example, only a few records included use of the partograph, a tool used to track progress so as to avoid a prolonged labor or ruptured uterus. Additionally, high rates of complications accompanying intrapartum stillbirth could show a gap in care when such complications arise and EmONC practices must be followed. To improve EmONC practices and lower intrapartum stillbirth rates, detailed record keeping for continuous analysis is suggested. This may allow for improvement of care during labor, specifically surrounding common complications. Any improvement should then be monitored with continued use of the BABIES matrix.

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Low-cost, Speculum-free, Automated Cervical Cancer Screening: Bringing Expert Colposcopy Assessment to Community Health

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Background: Although cervical cancer is on the decline in high income countries, the WHO estimates that 88% of worldwide invasive cervical cancer mortalities occur in LMICs and is expected to increase to 98% by 2030. Our work seeks to ameliorate key barriers to cervical cancer screening by developing: **1)** a speculum-free alternative, using an inserter and the POCkeT Colposcope, a Point of Care Tampon-sized digital colposcope, for a more comfortable exam, that also allows for self-colposcopy; and **2)** an image processing algorithm to aid health workers in the automated classification of cervical pre-cancer lesions real-time, using extracted features.

Methods: *Speculum-free device:* we explored a broad array of designs for a speculum alternative using computer aided finite element analysis and empirically validated the findings using a vaginal phantom. The top two designs were then evaluated under an IRB approved study (n = 15 volunteers) to assess the devices for cervix visualization, comfort and usability. *Automated screening:* we have developed image processing tools to extract features from digital colposcopy images based off acetowhitening and Lugol's Iodine staining. The algorithm first performs specular reflection removal, followed by Otsu's thresholding method, and feature extraction. Our algorithm was trained on 42 normal and pre-cancerous cervical images with Lugol's Iodine applied to determine sensitivity and specificity when compared to gold standard.

Findings: *Speculum-free device:* Studies with fifteen volunteers for self-insertion and physician-assisted cervix image capture, showed adequate cervix visualization for 83% of patients. Survey responses from volunteers indicated a 92.3% overall preference for the inserter over the speculum and all volunteers indicated that the inserter was more comfortable than the standard speculum. *Automated Diagnosis:* The pilot algorithm was able to classify 42 test images as normal or pre-cancerous with sensitivity of 85.7% sensitivity and specificity of 89.2%.

Interpretation: This study demonstrates the feasibility for comfortable, speculum-free image capture of the cervix and potential of an automated diagnostic algorithm for use by untrained community health workers and nurses in the field, with potential for self-screening. Ongoing studies seek to enable image classification as normal, low- or high- grade and also incorporate contrast enhancing approaches with the device.

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Evaluating the Cost-Effectiveness of an Integrated Program to Reduce Maternal and Neonatal Mortality in Ghana

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Background: Few studies have examined the cost effectiveness of facility based interventions in low-resource settings aimed at improving obstetric care. From 2007–2011, Kybele, an international NGO, partnered with the Ghana Health Service (GHS) to improve obstetric care through an integrated program addressing systems, skills, and leadership at a large tertiary hospital in Ghana. Despite doubling of patient volume and quadrupling of high-risk patients during this period, maternal mortality and still births were reduced. This study evaluates the program's cost effectiveness.

Methods: Costs included those incurred by Kybele, the GHS, and the value of time of volunteer medical workers traveling to Ghana, reported in 2015 \$US dollars (USD) adjusted for purchasing power parity (PPP). Benefits were calculated by modeling the counterfactual. Baseline case-fatality rates (CFR) were determined for hemorrhage and hypertensive disorders, the most common causes of maternal mortality. Deaths averted were modeled using a steady-state assumption for CFR predicting mortalities that would have occurred without program implementation. Model assumptions were tested with Monte Carlo simulations over 10,000 hypothetical scenarios. Maternal and newborn disability-adjusted life-years (DALYs) averted and the cost-effectiveness ratio [(CER); cost per DALY averted] were determined for each modeled scenario. The WHO defines a project as highly cost-effective if the CER is less than the country-specific GDP per capita, which, for 2007–2011, is \$2,917 in Ghana adjusted for PPP.

Findings: The total program cost was \$2,723,700. Models predicted that 236 (± 5) maternal deaths and 129 (± 13) intrapartum stillbirths were prevented, translating into 24,330 DALYs and a CER of \$112 (± 23) USD. This is well below the highly cost-effective threshold. Results were robust to sensitivity analyses with varying DALY calculation methods, yearly risk factor prevalence, and yearly case fatality rates. Across all scenarios modeled, the program remained highly cost-effective, with a CER ranging from \$112–\$265.