



Automated colposcopy

Towards improving access to reliable early detection of cervical cancer

Cancer of the cervix can be successfully treated if it is diagnosed and treated early. But in India eight women die from cervical cancer every hour. Too often the cancer is diagnosed at an advanced stage due to the lack of a national screening program and limited access to healthcare for large proportions of the rural population.

Philips is developing the next generation of colposcopes – a device used to detect pre-cancer and cancer in the cervix. By incorporating advanced image-processing algorithms and an improved user interface, the goal is to make it easier for less-experienced clinicians to use, and to interpret clinical findings. With more clinicians being able to reliably perform this test, the aim is to improve access to early detection and hence effective treatment of cervical cancer for women in India, and other developing countries.

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Cancer concerns

Cervical cancer is the most common cancer among Indian women. Two thirds of women diagnosed with cervical cancer in India are diagnosed at a late stage, when it is expensive and difficult to treat. As healthcare expenses are often paid out-of-pocket, this is inaccessible for poor families and can result in poverty for many other families. Death rates are high because of the advanced stage of the disease.

If cervical cancer is detected and treated early, then survival rates are high. However there is no national screening program in India for early detection and the effectiveness of existing screening techniques is low. This is due to the large size of remote rural populations, the lack of necessary infrastructure, availability of skilled healthcare workers, and access to information and the tests.

Many women have limited access to healthcare services as the spread across the country is not relative to population numbers: 60-70% of the population lives in rural areas, while 60-70% of the healthcare infrastructure is in urban areas. More than half of patients from rural areas need to travel over 5km to seek medical care.



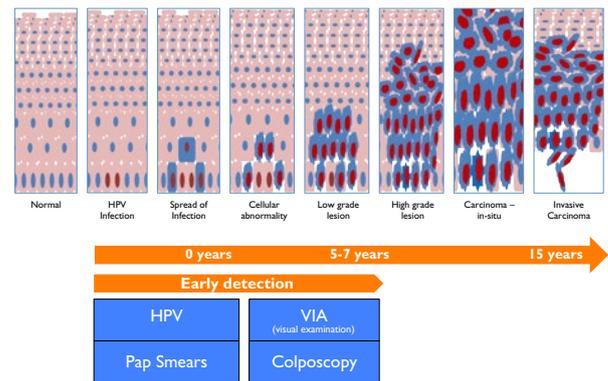
“India is losing eight women an hour to cervical cancer” explains **Dr Payal Keswarpu**, Principal Scientist and team leader for oncology, at the Philips Innovation Campus in Bangalore, India. “As a doctor who worked in this area before coming to Philips I’ve seen many women coming in at the late stages of cervical cancer. It’s really sad to see because it is almost untreatable – survival rates are less than 20% and treatment is expensive. We need to do something early on to help these women. When diagnosed early, treatment is relatively inexpensive and very effective.”

Collecting insights

The colposcopy project team in Bangalore met with healthcare workers, government departments, health charities and patients from urban and rural settings in India in order to fully understand all the issues relating to cervical cancer diagnosis and treatment. The aim was to establish needs and the ideal solution to address them.

The needs were specific to India, but they also apply to other low-resourced healthcare settings with large rural populations, such as China, East Africa and Indonesia. It was found that a cost-effective solution enabling early detection was wanted, but one that didn’t require a lot of expertise or training to use (particularly to assess the results of tests).

The progress and detection of cervical cancer



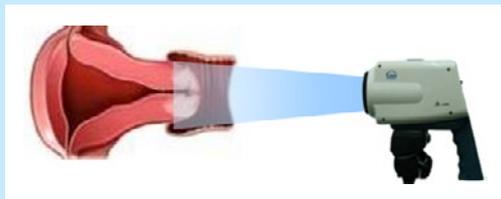
Screening for cervical cancer

Cervical cancer is mostly caused by infection by HPV (human papilloma virus). While many women get infected by the virus only a small fraction of women develop cancer. It takes around 15 years before the cancer becomes apparent. If detected and treated early, survival rates are high. Screening programs vary around the world, resulting in very different survival rates for the disease. In well-resourced Western countries Pap (Papanicolaou) smear tests and HPV tests are used to detect the early stages of cervical cancer. If an abnormality is found then a woman is referred for colposcopy and biopsy tests.

However in poorly resourced settings the situation is very different and these screening tools are not available. The HPV test is relatively expensive to perform, and there are not enough trained staff to interpret results of Pap smear tests. In India local healthcare workers carry out a basic visual examination with the naked eye, but there is no provision of light or magnification and no images are collected that can be checked by an expert.

“My local health worker has been suggesting that I go for a cervical cancer test to the hospital in the next village. But it is not possible for me to go so far on my own.”
(patient)

The **digital colposcope** was identified as the tool most suited to achieving the goal of high quality early detection. In well-resourced settings it is used as a second line of cervical cancer assessment and treatment. While in poorer settings its use for screening is increasing as it gives quick results, so patients don’t need to return to



The colposcope

Colposcopy is typically performed by a gynecologist to examine the cervix – using a colposcope which consist of a camera, a light source, and magnification – to detect signs of cancer.

Interpretation of the colposcopy images is difficult and requires expertise. Users need to be trained for months to years to be able to interpret images to a consistent and professional standard. However there is no professional training in countries like India, and across Africa, and even gynecologists aren't specifically trained to use the machine.



know the outcome, and so are less likely to be lost to follow-up. However, existing colposcopes can be difficult to use – especially by examiners who are less trained (see box: 'The colposcope'). So Philips began exploring how to develop an automated colposcope that would help guide and support the less experienced to use it.

Common errors

“At the beginning of the project, we spent time in clinics and hospitals to find out what the most common errors were in the colposcopy procedure, so we could see where most help could be offered;”

explains **Lu Wang**, research scientist and expert in user interaction. “We wanted to make sure the user interaction helped clinicians make full use of the technology that's in the machine, and so improve workflow and the quality of results.”



She observed and interviewed doctors and health workers in India carrying out the test. “While the examination only takes about five minutes to perform,

there are 15 different steps to it, and if any of them are forgotten or overlooked, then the results will not be as useful.” For beginners particularly, it's a challenge to do it all properly – they even need guidance identifying the right part of the cervix to look at.

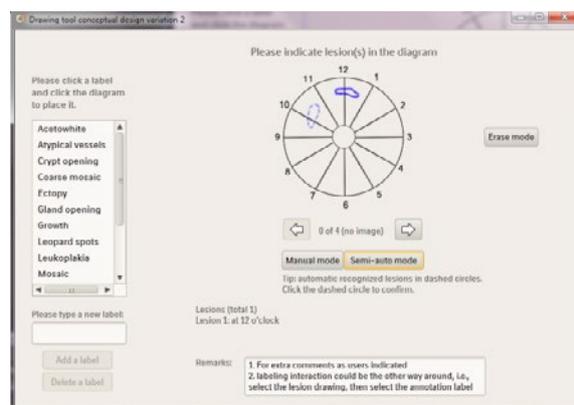
Improving performance

When problem areas are spotted during a colposcopy examination, they have to be described, such as the presence or absence of abnormal vessels and the type of 'mosaic'. These descriptions are quite subjective, so expertise is required to record them properly, as well as to interpret them. “We wanted to reduce the subjectivity of the process to help improve performance,” explains Lu Wang. There is lots of scope to misinterpret results and under- or over-estimate the situation.”

Next-generation colposcope

In response to all the insights gathered, the team developed a prototype for automated colposcopy that is simple and intuitive to use, while also offering more assistance than the existing ones. The majority of extra features are based on complex image-processing algorithms that help guide the user, and so create a more reliable procedure.

Following a colposcopy examination, the doctor usually indicates on a 'clock' diagram where cancer lesions are and indicates where major features, such as the 'transformation zone' are. Traditionally this is drawn on paper, but this new prototype digital system enables the doctor to record it on an interactive screen and store it digitally. It also serves as a double-check, as the system indicates where possible lesions could be, which the clinician can check and review.



The dark outline on the 'clock' is an area of concern highlighted by the user; the faint line is an area suggested by the machine.

Next steps

Initial verification of the algorithms on clinical data is showing promising results demonstrating the advantage of this technique. Full clinical validation in the field is expected to begin in the second half of 2014.

Rural outreach

The Asha Jyoti program ('Ray of Hope' in Hindi and Punjabi) is a mobile women's health outreach program in India. It provides screening to rural and urban-poor women in Punjab. Philips has donated the van and the medical equipment. The service offers cervical cancer screening using colposcopy, as well as screening for breast cancer and osteoporosis. Services like this would be greatly enhanced by the ability to offer automated colposcopy, so rural women could be given immediate results, with the potential to treat them straight away ('see and 'treat').

<http://www.newscenter.philips.com/main/healthcare/news/press/2012/20120924-rad-aid.wpd>

See video for more on Asha Jyoti:

<http://youtu.be/zx02U8LzdHY>



"Ideally we would like to have a single visit approach. The patient should get examined, diagnosed and get treatment if possible in the same visit."

(gynecologist)



Women in rural areas want access to local healthcare services that can help diagnose problems early on.

The advantage of a colposcopy test in a rural context is the near immediate results. Just five minutes after the examination the patient can be informed of results, rather than having to wait several weeks for them to come back from a lab (see box: 'Screening for cervical cancer').

The development of automated colposcopy has the potential to help to make the 'see and treat' approach to cervical cancer more accessible to women in India and other countries with low healthcare resources and large rural populations. This is the ideal way to work in developing countries where many women are lost to follow up," explains Payal. "There are currently too many steps in the process, and many women are unable or unwilling to repeatedly come back to clinics which may be a considerable distance from where they live."



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For further information contact:

Matthew Harris

Philips Design & Innovation Communications

Tel: +31 (0) 6316 99310

E-mail: matthew.harris@philips.com