Military surveillance system for breast cancer detection

Thomas S. May, freelance writer

The failed cancer diagnostic tool of thermography could soon have a new life, if two separate projects sponsored by the US Department of Defense (http://www.dod.gov) can succeed in adapting military surveillance tools for cancer detection. Both projects are enhancements of older thermal imaging technology, based on the principle that heat equals unwanted activity – in this case, unwanted cell growth.

The US Office of Naval Research (ONR; http://www.onr.navy.mil) is hoping to turn a high-tech military surveillance system, developed to detect enemy tanks hidden from view by camouflage or darkness, to breast cancer detection. The passive electro-optical system uses a pair of sensitive infrared cameras for remote sensing of heat distribution and, according to ONR researchers, it can also see tumours within breast tissue.

'Thermal imaging has been done by many, many countries for many, many years,' said Harold H. Szu, a research scientist with ONR (http://www.onr.navy.mil), one of the co-developers of a special algorithm that is used to analyze the large amounts of data collected by the two cameras.

'What is new is that we use multispectral thermal imaging. We look at two different spectral bands. That and the algorithm that we're using to analyze these data make the difference,' Szu explained.

According to ONR, the computerized system cannot only detect enemy tanks obscured by camouflage, but can also locate quickly growing cancerous tumours in a woman's breast, because abnormally reproducing cells generate higher than normal concentrations of

heat. Szu and his team confirmed this by detecting early stage ductal carcinoma (a form of breast cancer) *in situ* in a test patient, with the help of their military surveillance system.

Detecting heat versus detecting cancer

Although the initial results are encouraging, the system developed by ONR has not been tested on a large number of patients, and some experts doubt that it will be able to differentiate reliably between cancerous and non-cancerous breast tissue.

Kenneth R. Foster, a Professor of Bioengineering at the University of Pennsylvania (http://www.upenn.edu), notes that thermal imaging (thermography) has been used for several decades – with limited success – to detect breast cancer.

'The first wave of thermography died after studies in the 1970s and 1980s showed that infrared thermography had catastrophically poor sensitivity and specificity when used for screening for breast cancer,' he pointed out. 'Thermography takes pretty pictures, and gives very sensitive indications of the distribution of skin temperature,' Foster said. 'After decades of work on military applications, the quality of the imaging hardware has improved – it makes even prettier pictures.'

However, Foster questions whether the increase in sensitivity of the method (as defined in engineering terms) will result in higher sensitivity and specificity when it comes to detecting breast cancer. 'I am not convinced that better thermal imaging will solve this. It depends on how well lesion presence is correlated with skin temperature,' he cautioned.

Dynamic techniques might work better

Michael Anbar is a retired Professor of Biophysics who has been involved in thermographic breast imaging for more than 20 years. He suggests that dynamic area telethermometry (remote sensing of changes in skin temperature) might be more effective in identifying cancerous tumours than the static method developed by ONR.

In an article published in the May–June 2000 issue of *IEEE Engineering in Medicine and Biology*, Anbar points out that, according to a review of the literature, 'abnormalities in the distribution of temperatures over the skin of human breasts cannot be used as a reliable criterion for the presence or absence of cancerous lesions' [2].

He argues, however, that measuring changes in skin temperature over time (10–20 seconds) can be used to detect cancer. The reason for this is that cancerous cells produce nitric oxide (NO), which attenuates the modulation of skin temperature, he writes.

Working as a consultant to OmniCorder Technologies (http://www.omnicorder.com/), Anbar helped to develop a system

1359-6446/02/$ – see front matter PII: S1359-6446(02)02511-4

to detect breast cancer using dynamic area telethermometry, in combination with sophisticated algorithms to analyze the data. The system also makes use of highly sensitive infrared camera technology originally developed by NASA's Jet Propulsion Laboratory for the military's Strategic Defense Initiative.

'We have developed some algorithms that were very effective in the dynamic domain,' Anbar said. Preliminary test results were very promising, he claimed, 'but because we only studied a relatively small number of patients, these results are insufficient to warrant clinical use of the methodology' [3].

More data needed

To convince others that its technology has merit, Anbar says, any company involved in developing thermal imaging equipment designed to detect breast cancer must run hundreds or thousands of tests on both normal and abnormal patients. 'They would have to look at patients for quite a while, and those patients would then have to go to excision surgery,' he explained, 'and then the findings of surgery would have to be compared to their findings.'

Both OmniCorder and ONR (in collaboration with hospitals located throughout the USA) are in the process of conducting such clinical trials. But it will take several years before they collect enough data to determine whether the testing methods they use have sufficiently high sensitivity and specificity to recommend the use of thermal imaging for the diagnosis of breast cancer.

References

1 Foster, K.R. (1998) Thermographic detection of breast cancer. *IEEE Eng. Med. Biol.* Nov–Dec, 10–14

2 Anbar, M. *et al.* (2000) The potential of dynamic area telethermometry in assessing breast cancer. *IEEE Eng. Med. Biol.* May–Jun, 58–62

3 Anbar, M. *et al.* (2001) Detection of cancerous breasts by dynamic area telethermometry. *IEEE Eng. Med. Biol.* Sept–Oct, 80–91

Inhalant induces tolerance against stroke

Stephani Sutherland, freelance writer

Scientists at the US National Institutes of Neurological Disorders and Stroke (NINDS; http://www.ninds.nih.gov) have used an idea that dates back to the early 20th century to devise a preventive strategy against stroke. If the treatment is as successful in humans as it was in rats, people could inhale a nasal spray to cut their risk of neurological catastrophe. The study showed that genetically stroke-prone rats that were given the vaccine were far less likely to have either an infarct or a hemorrhage, and the resulting damage was far less severe [1].

Stroke claims an estimated four and a half million lives each year worldwide, with millions more people affected by physical and cognitive disabilities. It is among the most difficult neurological conditions to treat, in part because the symptoms can be hard to recognize. Even the most advanced treatments for stroke are useless unless delivered within only a couple of hours of the brain attack. Despite a recent boon of insights from research into the molecular events underlying stroke, the results of clinical trials of new drugs have been disappointing [2]. Stroke prevention – rather than damage control – would improve the outlook dramatically [3].

A log jam in the brain

Unlike a conventional vaccine, the strategy in the rat trial induces tolerance [4]. Originally described in 1911, tolerance prepares the immune system to suppress a reaction, rather than to mount an attack, and the antigen is an endogenous – or 'self' – protein instead of an invader. NINDS senior investigator John Hallenbeck and his colleagues chose the adhesion protein E-selectin (ES), expressed by vessel endothelial cells, as their antigen. Regulatory T-cells normally flow through blood vessels, but during activation – mediated by inflammatory cytokines – ES is upregulated in the vessel wall, causing T-cells to slow down, to begin rolling along the wall, and eventually to become tethered to the protein platform. Other molecules aggregate at the site, causing a log-jam in the vessel that can lead to thrombosis.

Hallenbeck speculates that the cyclic pattern of activating and subsiding could be intensified in the stroke-prone rats, so that the system gets into a positive-feedback situation – to a point of no return – that leads to stroke. By making the immune system tolerant to ES, the team hoped to shut down the cycle at its foundation.

'One advantage of tolerance is 'bystander suppression,' explained Howard Weiner, a neurologist at Harvard Medical School and Brigham and Women's Hospital (http://www.brighamandwomens.org/) who was not part of the study team. When you initially present an antigen – in this case ES – the immune system is trained to recognize that protein specifically, but the suppression is not exclusive; it occurs wherever that protein is expressed. Now imagine that other proteins act at that same site. Those bystanders are suppressed along with the initial antigen. The molecular co-localization lends non-specificity to the mechanism of tolerance. This feature lends insight to the molecular events:

 1359-6446/02/$ – see front matter PII: S1359-6446(02)02510-2