Nationwide breast cancer screening in the Netherlands

G. Den Heeten National Expert and Training Centre for Breast Cancer Screening, Radboud University Nijmegen Medical Centre, Nijmegen, the Netherlands. Department of Radiology, Academic Medical Center, Amsterdam, the Netherlands.

M. Broeders National Expert and Training Centre for Breast Cancer Screening, Radboud University Nijmegen Medical Centre, Nijmegen, the Netherlands. Department of Epidemiology, Biostatistics and Health Technology Assessment, Radboud University Nijmegen Medical Center, Nijmegen, the Netherlands.

Figure 1. The Netherlands Breast Cancer Screening Program.

In the Netherlands, the RIVM (National Institute for Public Health and the Environment) provides a free nationwide breast cancer screening service for all women between 50 and 75 years of age. The service covers the entire country (Figure 1). Close to a million women are examined per year, representing more than 80% of the target group. This is one of the highest participation rates worldwide.

The screening service was introduced in 1989 for women between 50 and 70 years of age, and was extended to the 70-75 year old age range in 1998.

This article provides a brief overview of the service for those unfamiliar with the Dutch situation, describing the historical background of the service, the current situation and the results achieved so far, and offering a glimpse into the future.

The screening service

For many decades, breast cancer has been the most common form of cancer in women, and the most important cause of death from malignant disease. There are more than 13,000 new cases of breast cancer per year in the Netherlands, and according to the most recent data 3,300 deaths, among a total population of 16,000,000 [1].

The nationwide screening service for breast cancer, known as BOB from the initials of the Dutch title (Bevolkingonderzoek op Borstkanker) has been set up by the Dutch government for asymptomatic women between 50 and 75 years of age. The primary test offered is X-ray mammography, aimed at early detection of breast cancer in order to reduce the mortality from this disease. The examinations are performed in 14 fixed units at strategic locations in the country, and a

In the Netherlands, the government provides free nationwide breast cancer screening.

▲
Figure 2. Mobile screening unit.

fleet of 52 mobile screening units (Figure 2). The examinations are organized, assessed and archived by nine regional screening organizations, coordinated by one central organization.

Before the government offered such a service, it was necessary to demonstrate its cost effectiveness. In addition, the use of ionizing radiation in the Netherlands requires a license under the law governing population screening (Wet op het Bevolkingsonderzoek – WBO). This law is intended to protect the population from screening procedures that could be injurious to health.

▶ Since the introduction of screening, there has been a continuing reduction in mortality.

The nationwide screening service is financed directly from taxes, and therefore falls outside the standard healthcare insurance schemes. The government sets a standard of quality that the screening organizations have to meet, with continuous monitoring of the overall figures and performance indicators, and a training and visitation scheme.

Historical background

As early as 1968, Wilson and Jungner [2] described a number of criteria that a screening program would have to meet. It is beyond the scope of this article to deal with all of these criteria, but the first essential is to have a practical and effective test. The only validated test for breast cancer that can be applied to a large asymptomatic population is X-ray mammography.

In the latter half of the twentieth century prospective randomized trials were carried out in several countries directed towards estimating the impact of mammographic screening on the reduction of breast cancer mortality. The favorable results of these trials and two pilot projects in Utrecht and Nijmegen in the Netherlands, together with a cost/benefit analysis, were the basis for the introduction of breast cancer screening in the Netherlands.

In addition to the reduction in mortality, there are several other indicators that can be used to assess the success of a screening program. These are referred to as surrogate indicators, and include:

- incidence of interval cancers (i.e. those diagnosed after a negative mammographic screening procedure and before the next scheduled screening)
- stage of tumors discovered at screening
- proportion of tumors detected with a diameter less than 1 cm
- ratio between ductal carcinoma in situ (DCIS) and invasive tumors
- proportion of tumors detected with positive lymph nodes.

These surrogate indicators have been shown to provide a good indication of future mortality reduction. We can confidently assert that no other healthcare sector has been so carefully evaluated and supported as breast cancer screening with X-ray mammography.

Results

Since its introduction in 1989, breast cancer screening has detected more than 50,000 cases. From the beginning of the program, the surrogate indicators described above have been shown to correlate well with the outcome. From a participation of about 75% in the early years, recent years have shown a slow but steady increase to more than 80%. This shows that screening has now become an accepted phenomenon.

In the beginning, the National Expert and Training Centre actively encouraged a referral rate for further examination of 1%, in view of the original reluctance to accept this type of screening. However, as the referral rate continued to reduce, and dropped below 1%, an "optimization study" was carried out. This study, performed with the aid of Dutch screening radiologists and European experts, indicated that the referral rate should be increased [3].

Since 1994 the Dutch screening radiologists have, in fact, increased the referral rate, reaching an average of 1.6% in 2006. Happily, this has been accompanied by an increase in the detection rate in the following rounds, which is now about 5 carcinomas per 1,000 women screened.

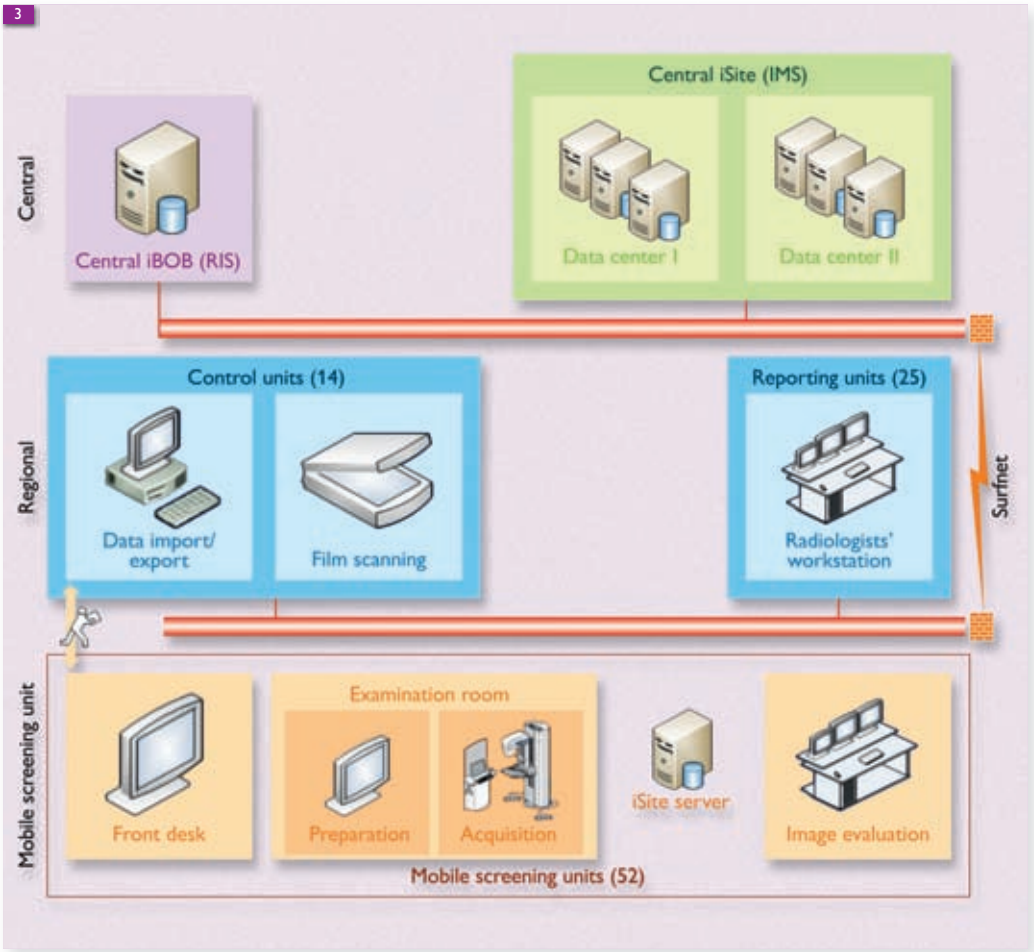

Figure 3. Philips Image Management System.

The increase in the referral rate has been achieved by the active participation of the screening radiologists, the National Expert and Training Centre's visitation system, and communications from members of the National Evaluation Team in Nijmegen and Rotterdam. Informally, an upper limit of 2% is regarded as acceptable [4].

Since the introduction of breast cancer screening there has been a continuing reduction in breast cancer mortality at both national and regional level. The extension of the age range to 75 in 1998 has been accompanied by a reduction in mortality in the older age group since 2002. From 1989 to 2006, mortality in the 55-75 year old age group was reduced by 24%.

The only detailed performance figures available in the Netherlands are for those women who actually participated in the screening. Extrapolation of the available figures for the population as a whole, and comparison with countries such as Sweden where such an analysis has been carried out, indicates that the reduction in this group is about 40%. In other words, a woman who participates in breast cancer screening reduces her risk of dying of breast cancer by 40%.

The screening program has had an enormous influence on breast cancer care in the Netherlands. The influence of better organization (multidisciplinary breast teams), improved treatment (such as chemotherapy) and improved surgical techniques regularly leads to discussions of what effect can be attributed to which factor. Such discussions are probably irrelevant, because in any case it is evident that mass screening and increased alertness have led to more favorable staging of manifest tumors in the group as a whole.

Cost effectiveness

The mass screening program costs around € 45 million per annum. Corrected for inflation, the costs have reduced rather than increased. There are few overheads and the majority of the screening organizations are well run, with high productivity. Since 1994 the efficiency has been increased still further.

Cost effectiveness analyses carried out by investigators at the Erasmus University in Rotterdam, the Netherlands, show that at least 800 fewer women die of breast cancer each year, at a cost of about € 4,000 per added year of life. To the best of our knowledge, no other mass screening project even approaches this result.

A woman who participates in screening reduces her risk of dying of breast cancer by 40%.

Recent developments

The existing analogue mammography units are being replaced by digital systems.

The government is currently implementing a program of regional coordination and modernization, in which the existing analogue mammography units are being replaced by new digital systems, linked via a nationwide image management system with a central archive and 25 remote reporting units at various locations in the country, staffed by specially trained screening radiologists.

The reporting units are provided with workstations, each with two high-resolution screens for assessing the digital mammograms, and a regular screen for textual information. These are connected directly to a central archive via a 1 Gigabit nationwide optical network, allowing the radiologists to access the patients' records, including multiple mammograms, in seconds.

Digital imaging eliminates the need for cassette handling, processing and bulky archives, while the brightness and contrast of the digital images can be adjusted for optimum viewing.

Digital archiving

Digital archiving of all mammograms from all over the country requires a vast storage capacity. Digital mammograms are typically around 70 MB uncompressed, or 30 MB compressed, with an average of four per client for about a million clients, representing 30 TB of data per annum. Furthermore, the mammograms have to be stored for a minimum of 15 years, and it must be possible to retrieve any given mammogram within seconds.

The Philips iSite PACS was chosen as the centralized image management system.

To meet these requirements, the RIVM invited tenders from a number of manufacturers. Following a stringent selection procedure, and a test period in which the Philips solution met the requirements, Philips was chosen as the project manager, with Philips iSite PACS as the nationwide image management system (Figure 3).

The decision was based on Philips' expertise in medical imaging and healthcare informatics, as well as the proven capabilities of the Dutch Philips Healthcare Informatics organization in managing large and complex IT solutions for radiology and cardiology. Philips also has the advantage of being the first supplier in the Dutch market offering a pay per study PACS: iSite PACS.

In addition to its own products and services, Philips leads a consortium of specialized suppliers. The secure nationwide infrastructure will be provided by the Netherlands SURFnet optical network, and the secure national central archives will be housed by ATOS Origin.

At present, each region has its own database and the three pilot regions each have a PACS. Philips will be responsible for migration from these to the national archive.

Secure nationwide fiberoptic network

The iSite PACS distributes the images and data via a secure, nationwide fiberoptic network, making them in principle available to authorized healthcare professionals in seconds. An additional benefit is that hospitals will have direct access to the images, eliminating the need for repeated examination and the attendant radiation exposure.

The new service currently comprises nine Regional Screening Organizations, each with one or more Central Units responsible for invitations, process control, and archiving and communicating images and data.

Images and data within the screening units are communicated to the resident workstation using iSyntax, with DICOM communication through the network. Images and data from the mobile units will be recorded on hard disc and couriered to the Central Units.

Implementation

Migration to the new system is already well under way. Two "mirror" Central Archives have been set up in the Eindhoven area, and the first regional central units are on-line.

The nine Regional Screening Organizations are currently being merged into five regions, and all regions are expected to be integrated in the new system by July 2010.

The transition to the new system is complex and far-reaching, requiring the cooperation of all parties, not least the radiologists concerned.

The introduction of nationwide digital screening also requires harmonization of the radiological working procedures, as there are regional differences, some of which are quite significant.

The National Expert and Training Centre has been asked by RIVM to facilitate the transition from analogue to digital screening by providing training specifically directed toward achieving standardized working methods. The training program is compulsory and includes familiarization with the BI-RADS (Breast Imaging - Reporting and Data System) assessment categories, standardized image processing, and

insight into the effects of this method of working, such as temporary recall peaks.

Considerable benefits are expected when the digital working method has been fully implemented and any teething troubles are overcome. There is good reason to suppose that an even higher level of detection will be achieved, and implementation of the digital system may also be a good opportunity to lower the starting age to 45 years. However, there is still a lot of work to be done in order to fine-tune the system, including developments such as Computer Aided Detection (CAD), automated density scoring, other forms of risk stratification, multimodality imaging, expert panels, continuous on-line quality control, and continuing education.

The screening radiologists in the Netherlands will soon be part of a mammography practice performing close to 1,000,000 examinations per year with 180 similarly trained radiologists and 500 technicians, who will be working together to prevent some 1,000 deaths from breast cancer per year. This is a task that, to the best of our knowledge, does not have its equal anywhere in the world ■

▶ **Images and data are available in seconds via a secure, nationwide fiberoptic network.**

References

[1] www.ikcnet.nl

[2] Wilson JMG, Jungner G. *Principles and Practice of Screening for Disease.* WHO, Geneva 1968. http://whqlibdoc.who.int/php/who_php_34.pdf

[3] Otten JDM, Karssemeijer N, Hendriks JHCL, Groenewoud JH, Fracheboud J, Verbeek ALM, et al. *Effect of Recall Rate on Earlier Screen Detection of Breast Cancers Based on the Dutch Performance Indicators.* J Natl Cancer Inst 2005; 97: 748-754.

[4] Landelijk Evaluatie Team voor Bevolkingsonderzoek naar Borstkanker Tussenrapportage 2007. (National Evaluation Team for Breast Cancer Screening; Interim Report 2007). Department of Social Healthcare, Erasmus University Hospital Rotterdam.