The cost-effectiveness of a population-based mammographic screening program in Lower Silesia, Poland

By Dr Bartłomiej Szyngiarewicz and Prof Rafal Matkowski

In this article, we present a summary of our recent analyses of the cost-effectiveness of the organized and population-based breast cancer screening program in the Polish region of Lower Silesia, which has a population of 3 million people [1-3]. We show that the cost of cancer detection through high quality mammographic screening is relatively low, which makes the program applicable in other health care systems, even those in emerging economies.

The potential benefits of mammography screening need to be carefully balanced against the financial burden for the state in countries which have a national health care system [4]. In many high-income economies, mammographic screening has been widely implemented; various improvements in breast cancer outcomes, such as decreases in mortality have been attributed to such screening mammography programmes [5-7]. However, in countries with emerging economies and which are in the process of introducing nation-wide programs, the cost-effectiveness of population-based screening has to be particularly taken into account. Although Poland is ranked by the World Bank among the high-income countries (http://data.worldbank.org/country), the gross national income (GNI) per capita of 13 730 USD remains considerably lower than that in Western Europe, and is in fact just slightly above the borderline value of 12 616 USD. The country's economic situation has resulted in a severely limited health care budget. There are mixed data on the economic attractiveness of screening mammography in low- and middle-income countries but the evidence base on this is still too small to generalize the findings or draw and extrapolate any significant conclusions [8].

Population-based breast cancer screening in Poland has been fully operational since the 1st of January 2007 (after a pilot phase in 2006) under the auspices of the Polish National Health Fund. This nation-wide program targets women aged 50-69 who are not undergoing treatment or being followed-up for breast cancer. Personal invitation letters are issued centrally by the National Health Fund using its population register. Two-view (namely cranio-caudal and oblique) screen-film mammography is used as the standard screening test. The usual length of a round of the program is two years. All women with suspicious findings on imaging are recalled for assessment. The second level diagnostic tools that are used are breast clinical examination, additional imaging, and invasive investigations if needed. Following further assessment women with benign lesions are referred for mammography at the routine round duration of the program, while women with lesions of uncertain potential of malignancy are referred to a short-term follow-up after 6 months. Women in whom breast cancer has been detected are referred for treatment — image-guided biopsy (core-needle or vacuum-assisted). During the initial (2007-2008) and first subsequent (2009-2010) rounds

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of screening, the technical recall rate in the programme was 0.27% and 0.1% respectively whereas further assessment rates were 6.2% and 4.5%, respectively. The cancer detection rates, both invasive and ductal carcinoma in situ, were 6.6/1000 and 5.5/1000 while the cancer detection rate expressed as a multiple of the expected breast cancer incidence rate was 3.8 and 3.3, respectively [9,10].

The general assessment using early indicators reveals that the diagnostic service conforms to the European standards at an acceptable or even desirable level [11].

Data for our investigation were collected in a prospective manner using the SIMP computer system (the official electronic system for the monitoring of prophylaxis programs), as well as the databases of the regional branch of the National Health Fund and the Lower Silesia Cancer Registry. The amount of expenses incurred was obtained from the Regional Coordinating Center for Screening Programs for each year that was analyzed. The number of screen-detected cancers comprises both ductal carcinomas in situ and invasive breast cancers.

The costs of invasive investigations are included in the costs of the further assessment, with the exception of vacuum-assisted biopsy that is reimbursed separately. Costs were measured, converted into US dollars (USD), and expressed in 2016 USD using the comparison of purchasing power of money calculated using the Consumer Price Index (CPI). Financial calculations were calculated using the database of the Polish National Bank (www.nbp.pl) to determine exchange rates and the Measuring-Worth service to measure the value of amounts in USD over time (www.measuringworth.com).

The analysis of cost-effectiveness is presented round-by-round in detail in Table 1.

To summarize, the total expenses for the screening program in the initial (2007-2008) and subsequent rounds (2009-2010, 2011-2012, 2013-2014, and 2015-2016) were $4,793,904, $6,122,074, $6,569,137, $5,977,504, and $5,127,213 USD while the numbers of cancers detected were 1,049, 987, 1,312, 1,070, and 1,009. The cost-effectiveness ratio obtained in the program for each round was $4,570, $6,203, $5,007, $5,586, and $5,081 USD per cancer found.

During the 10 years of the population-based program, the total expense for screening expressed in USD was 28,589832 and the number of detected cancers was 5427. Thus the average cost of each breast cancer detected in the screening program in the region of Lower Silesia in the period of 2007-2016 was $5268 USD.

As we have pointed out elsewhere, it is difficult to compare the costs and effects among different screening programs [2]. In general, organized and centralized programs tend to increase the cost-effectiveness of mammographic screening, mainly because of better organization, attendance rate, the use of extended invitation scheme covering a large part of the eligible population and comprehensive quality assurance procedures [4]. Published cost-effectiveness ratios may differ tremendously, and are often the result of different methods of calculation, different time periods being considered, and the inclusion or exclusion of downstream cost.

The impact of a screening programme depends on many factors, such as the epidemiology of the disease, the health care system, the quality of program, and the costs of health care [12].

### Table 1. Detailed cost of breast cancer screening in the region of Lower Silesia in the years 2007-2016 presented round-by-round and expressed in 2016 USD

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<tr>
<td>Screening mammograms</td>
<td>4,104,338</td>
<td>5,524,312</td>
<td>5,842,888</td>
<td>5,312,698</td>
<td>4,510,567</td>
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<tr>
<td>Recall and further assessment</td>
<td>209,860</td>
<td>211,453</td>
<td>186,383</td>
<td>165,742</td>
<td>178,262</td>
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<tr>
<td>Invitations letters and leaflets</td>
<td>137,431</td>
<td>146,196</td>
<td>190,576</td>
<td>146,770</td>
<td>118,661</td>
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<tr>
<td>Regional coordinating center</td>
<td>342,275</td>
<td>240,113</td>
<td>349,290</td>
<td>352,294</td>
<td>319,723</td>
</tr>
<tr>
<td>Total expense</td>
<td>4,793,904</td>
<td>6,122,074</td>
<td>6,569,137</td>
<td>5,977,504</td>
<td>5,127,213</td>
</tr>
<tr>
<td>Cancers detected</td>
<td>1,049</td>
<td>987</td>
<td>1,312</td>
<td>1,070</td>
<td>1,009</td>
</tr>
<tr>
<td>Expenses per cancer detected</td>
<td>4,570</td>
<td>6,203</td>
<td>5,007</td>
<td>5,586</td>
<td>5,081</td>
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1. invasive cancers and ductal carcinomas in situ
Analysis using a computer model has shown that these marked differences make it impossible to set up one uniform policy for all countries [4,12]. When we evaluate the cumulative expense for mammographic screening with regard to the number of cancers found, our program looks favorable. If we compare the same period at the start of the program in other countries, the reported cost of cancer detection expressed in 2016 USD varied from $11544 in Italy, (1991-1992) to $13106 in Spain, (1995-1996) [13,14]. Our screening seems to be much more cost-effective but the limitations of such comparisons should be kept in mind.

However this difference is in any case hard to explain. It could have been influenced by many factors, since the number of cancers detected is the result of screening sensitivity, incidence of breast cancer in the eligible population, and the percentage of women screened [15]. In addition, lower reimbursement rates and salary levels in the Polish health care system compared to those in Western Europe are among other possible explanations. Some performance indicators can reflect the cost-effectiveness of screening program. Taking all this into consideration, our service seems to work well. The recall rate is acceptable, minimal-invasive biopsy rate (core-needle and vacuum-assisted) is at a desirable level (95%) while the cancer-to-biopsy ratio is very high (72%) [9,10]. The main disadvantage of our studies is the fact that since vacuum-assisted biopsy is reimbursed separately so its cost is not included in the total expense for the screening program. For the convenience of the women undergoing mammography more than 90% of screening mammograms are carried out in many small services outside our hospital, although still adhering strictly to high quality standards. In contrast however, the vast majority of vacuum-assisted procedures in the region of Lower Silesia and almost all biopsies for screen-detected abnormalities are in fact performed in our institution. Hence, some conclusions regarding biopsy costs can still be drawn. The reimbursement rate for vacuum-assisted procedure in Poland during the 2007-2008 period was approximately $1000 USD. This type of biopsy offers a lot of advantages but because of limited budgets it was generally reserved for microcalcifications (under stereotactic guidance) and for very small mass lesions (ultrasound-guided). In 2007 the number of cancers found in screening program was 543. As we reported elsewhere, in the same year a minimal-invasive biopsy rate was 95% while a benign-to-malignant ratio was 1:2.55, which gives a cancer-to-biopsy ratio as high as 72% [16]. To confirm the malignant histology of screen-detected lesions the total number of core-needle and vacuum-assisted biopsies performed in the year was 254 and 462, respectively. If we include the additional cost of vacuum-assisted procedures ($462000 USD) in the total expense for the screening program the cost of cancer detection in 2007 will rise up to $4936 USD, which however still remains relatively low.

CONCLUSION

Our findings indicate that, because of the low cost per cancer detected, a population-based mammographic screening conforming to the European quality standards is cost-effective for emerging economies. Such screening programmes should be an important part of the public policy even in countries with tightly limited health budget.

REFERENCES

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ACKNOWLEDGMENT

The authors wish to thank Dawid Blasszyck (Regional Coordinating Center for Screening Programs, Lower Silesia Oncology Center, Wroclaw, Poland) for his kind and careful assistance in data collection and analysis.

CONFLICTS OF INTEREST

None declared