

What is the economic impact of secondary prevention to society?

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KEY WORDS

1. *Of the 4.1 million population of Norway about 7500 patients between 20 and 75 years of age are admitted each year to hospital for acute myocardial infarction. Of these 1100 die in hospital, and 6400 are candidates for secondary prevention. On the basis of survival curves, we present a model for calculating potential benefits of secondary prevention. We use 'years of life gained' as a measure of outcome of secondary prevention.*
2. *We consider three economic elements in secondary prevention:*
 - (a) *Use of health services. The drug costs are moderate. The indirect costs are unknown, but probably moderate.*
 - (b) *Resumed productivity is small.*
 - (c) *Pensions and other transfers will increase the public expense.**The net effect is an increase in public expense.*
3. *Beta blockers reduce mortality by 25% and can be given prophylactically to about one third of the patients. So far, the effect is uncertain after two years. Secondary prevention for two years will cost Norway about 3.8 million NOK (526 000 US \$) per year for drugs, give 597 extra survivors and provide 0.24 additional life years per patient treated. In case of life-long treatment and effect, the result will be 1.6 years of life per patient treated.*
4. *About 50% of Norwegian patients smoke. If all the men stopped, there will be no costs, about 5120 extra survivors, and 3.3 additional years of life per patient who quits smoking. The effect is not limited in time.*

Doctors often see health economics as a branch of accounting, or simply the practical task of adding expenses. However, health economics is a science concerned with allocation of scarce resources for health. Here we shall examine a special clinical problem in the light of health economics. The problem is secondary prevention after myocardial infarction, i.e. measures offered to survivors of myocardial infarction to prevent sudden death, a new infarction or other cardiovascular complications. The reduction in mortality is generally used to measure success.

General concepts of health economics

Economists have introduced the concept of cost-benefit analysis to study difficult choices. The idea is simple: costs are added in the numerator, benefits in the denominator. Both must be in the same units — money. If the fraction is less than 1,

the project is worth considering. However, there are one small and two large problems. The small problem is to add the right costs in the numerator. The first difficult problem is to translate benefits into money, for example life, happiness, absence of pain and all the other things that make life worth while. This exercise requires a reasoning which is very difficult and often so dubious that we prefer not to do it. The second difficult problem is that the real cost of a project is not the money involved, but the alternative projects that cannot be carried out because the money is allocated to the first project. This is the so-called opportunity cost. Thus, the economist accepts that the same sum of money can only be used once, and — ideally — it should be used for that project which gives more benefits than any other conceivable project — in medicine or in any other field. Clearly, cost-benefit analyses impose insolvable difficulties. Yet, systematic thinking along these lines can often clarify difficult choices.

Cost-effectiveness analysis offers a possible way out of these dilemmas. The numerator is the same, but the denominator is no longer in money, but in terms relevant to the project—in medicine, for example, in the number of years of life saved. This may make it impossible to compare different projects, but the analysis is nevertheless helpful.

Finally, economists distinguish between real and financial economy. Real economy relates to production of goods and services. Financial economy relates to transfers of money, such as taxes and pensions. For example, if a population changes in such a way that the number of employed people stays constant, but the number of non-employed (especially elderly) increases, this will affect the financial but not the real economy. Production stays constant, but public expenses and transfers from the employed to the non-employed increase.

The model

To examine the problem of secondary prevention after acute myocardial infarction, we need a model. In the following we present such a model based on Norwegian statistics.

Norway has 4.1 million people. According to the hospital statistics, about 14 000 patients were admitted to hospitals in 1980 for acute myocardial infarction^[1]. About 69% were men, and 73% were below 75 years of age. The average stay in hospital was 12.3 days. These statistics are not accurate and probably overestimate the number of acute myocardial infarctions.

We believe the data collected by the Norwegian Timolol study^[2,3], which included 20 hospitals covering about 1.3 million people, are more reliable. All patients admitted for possible acute myocardial infarction were systematically evaluated. During a little over 19 months 4155 patients between 20 to 75 years of age were found to have a confirmed acute myocardial infarction. This suggests that about 7500 patients who are between 20 and 75 years of age are admitted each year to Norwegian hospitals with a confirmed acute myocardial infarction. The mortality before entry to the study (at most, 28 days after onset of symptoms) was 12.2%. We take this mortality to be similar to the general hospital mortality, or a little less. Thus, we assume that about 15% or 1100 patients die in hospital, and 6400 patients between 20 and 75 years of age will leave hospital after an acute myocardial infarction every year. Based on

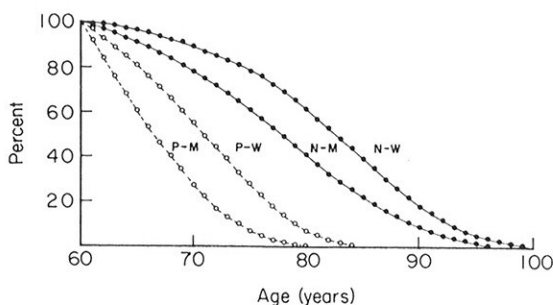


Figure 1 Survival curves for 60 year-old Norwegian men and women: N-M, normal population, men; N-W, normal population, women; P-M, men after an acute myocardial infarction; P-W, women after an acute myocardial infarction.

the data from the Timolol study^[2,3] we assume that 80% (5120 survivors) are men and 20% or 1280 are women. We also assume that the mean age is 60 years, i.e. we base our calculations on the assumption that all patients are 60 years old.

Figure 1 shows the survival curves for two groups (men and women separately):

- normal population,
- survivors after acute myocardial infarction not treated prophylactically (= placebo group in the Timolol study). The Timolol study lasted for about two years, and we assume that the mortality trend continues after that. This is supported by the data of another study^[4].

In these curves we consider only the total mortality. Cardiac mortality is lower. During the first two years after myocardial infarction 7% of the deaths were non-cardiac in the Timolol study^[2,3]. This figure increases with time. For example, it was 32% 3–15 years after the infarction in one study^[4].

In a stable population the number of survivors will be equal to the sum under these curves adjusted for the initial number of persons. These figures also indicate the average remaining years of life expected, see Table 1.

The number of survivors (not given secondary prevention) at any one time will be:

men:	$5120 \times 7.6 =$	38 912
women:	$1280 \times 11.5 =$	14 720
total		53 632

Similar calculations for the number of persons 60 years and older in the total population in 1980 reveal:

Table 1 Average remaining years of life for 60 year-old cohorts of the normal population in Norway and of patients who have survived an acute myocardial infarction — without or with secondary prevention

	Average remaining years	
	Men	Women
Normal population	19.0	22.4
Patients after myocardial infarction:		
no secondary prevention (25% continue to smoke)*	7.6	11.5
secondary prevention with beta blockers, $\frac{1}{3}$ for 2 years*	7.9	11.7
secondary prevention with beta blockers, $\frac{1}{3}$ permanently (our calculations)	9.2	13.2
no secondary prevention (50% continue to smoke)†	6.8	—
prevention: no patients continue to smoke†	8.8	—

Sources: *Timolol study^[2,3]; †smoking study^[4].

men: $22\,560 \times 19.0 = 428\,640$

women: $23\,867 \times 22.4 = 534\,620$

total 963 260

From an economic point of view the manner of death is important. In the placebo group in the Timolol study 67% of the cardiac deaths were sudden^[2,3]. Thus, only $\frac{1}{3}$ of the cardiac deaths involved health services expenses.

The age distribution of the patients is also of obvious economic importance. According to Norwegian hospital statistics^[1], patients with acute myocardial infarction in the age group 20–75 years can be divided in two large groups: 53% are under 65 years of age (only 3% are under 45 years of age), and 47% are 65 years of age or older.

In our model we have only considered deaths. Obviously, impairment and suffering should also be included. However, we have no reasonable figures for this aspect of secondary prevention after myocardial infarction. We therefore limit ourselves to the prevention of death.

The accounting

Many doctors have taken such figures and added up the potential economic losses after myocardial infarction and the potential economic savings of secondary prevention. In general, there are three main items in such calculations:

(a) health services expenses: hospitals, consultations, drugs etc.

(b) lost production due to death before retirement age (67 years in Norway).

(c) pensions and other transfers over the public budgets.

Only the first two items are real costs, but in political discussions on health economy public expenses are often given more attention than real costs.

It seems simple enough to calculate these expenses, but doctors are often guilty of 'double accounting' when they argue for a program. For example, they frequently add lost production and compensation for sick leave. Here, we are not concerned with such details, but we shall consider some general points related to these three items.

In the calculation of health services expenses there is a major joker: all patients die sooner or later. If a patient is prevented from dying of a cardiac attack, he must die of something else. These alternative service expenses are well illustrated in Norwegian hospitals. The intensive care ward is expensive, but the major problem is the so-called blocked beds, i.e. beds occupied by patients needing long-term care. We do not have data for detailed calculations, but it does not seem economically rewarding to convert cardiac deaths — two thirds of which are sudden — into long-term care. Doctors, of course, revolt at this crude and cruel reasoning, because they see patients who become well and fit after myocardial infarction. This is true, but sooner or later these patients become old and die. Lives are never saved for good, death is only postponed. Thus, we simply do not have data to calculate the ultimate expense to the health services for patients given secondary prevention, but it seems reasonable that the total expense will increase.

Lost production is also a difficult problem. The prevention of cardiac deaths does not automati-

cally return the patients to work. In fact, in the Timolol study^[3] there was no significant difference in working activity between the two groups of survivors, suggesting that some of the patients who were saved by Timolol were not fit for work. This seems reasonable, since more lives were saved in the high risk group. Thus, secondary prevention is probably not very effective in preventing loss of production. To reach that goal, primary prevention is essential. In addition, there is a further complication in the calculation of lost production. In Norway, as in most Western countries, unemployment is a serious problem, and there is increasing pressure for earlier retirement to make room for younger unemployed people. Thus, calculation of lost production in the higher age groups is difficult from the point of view of economists. We stress, of course, that we understand the importance that the individual patient should return to work. However, here we are concerned with the effects on the economy of society at large.

Pensions are the last item. Old age, permanent disability and illness all lead to financial transfers in terms of pensions, insurances etc. over public budgets through taxes. These have, of course, no direct impact on the total economy, but are politically highly relevant.

In the normal cohort of 60 year-old men 60% of the remaining years of life will be after 67 years of age. However, in a cohort of 60 year-old male survivors after myocardial infarction not given secondary prevention only 24% of the remaining years of life will be after 67 years of age. Secondary prevention will therefore lead to *increased* need for financial transfers of the taxpayer's money.

In sum, increased expenses for the health services, virtually no effect on production, and increased public expenses for pensions — these are the likely effects of secondary prevention after myocardial infarction, irrespective of the costs of the specific intervention. Therefore, doctors should not argue dishonestly for secondary prevention, promising savings that are likely to be false. This should not discourage us, but we should use the honest argument: secondary prevention is good for the patients, and the costs are not unreasonable. It is important to emphasize, however, that secondary prevention should avoid marked side-effects and ensure an acceptable quality of life.

Many different means of secondary prevention have been proposed: antilipid, anti-smoking, anticoagulant, antiplatelet, antiarrhythmic, beta blockers, calcium blockers, coronary surgery,

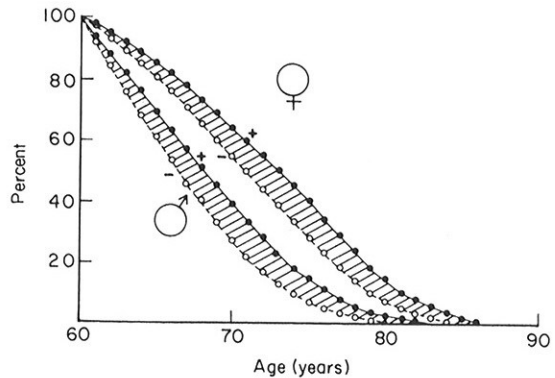


Figure 2 Survival curves for patients 60 years of age after myocardial infarction. For each sex there are two curves: —, no secondary prevention (25% continue to smoke); +, secondary lifelong prevention with Timolol in $\frac{1}{3}$ of the patients.

etc. These measures vary in cost, duration and effectiveness^[10]; however, we believe that the two best documented and interesting so far are beta blockers and to cease smoking.

Beta blockers

Several beta blockers reduce cardiovascular mortality following myocardial infarction^[5-9]. In general, the mortality is reduced by 25% in all risk groups. The effect has been demonstrated during the first two years, but may possibly last longer. Roughly, the patients can be divided in three groups with regard to beta blockers:

- (1) $\frac{1}{3}$ should have beta blockers for therapeutic reasons, especially for angina and hypertension;
- (2) $\frac{1}{3}$ have some contraindications or develop unacceptable side-effects;
- (3) $\frac{1}{3}$ may use beta blockers solely for secondary prevention.

We have examined the effect of lowering the mortality by 25% for one third of the 6400 survivors 20–75 years of age. The mortality in the first year is about 11%^[2,3]. Thus, about 60 patients would be 'saved' in the first year. Assuming that the treatment and the effect continue for life, the number of survivors will be (see Fig. 2):

men:

$$(5120 \times \frac{1}{3} \times 9.2) + (5120 \times \frac{2}{3} \times 7.6) = 41\ 643$$

women:

$$(1280 \times \frac{1}{3} \times 13.2) + (1280 \times \frac{2}{3} \times 11.5) = 15\ 445$$

total

57 088

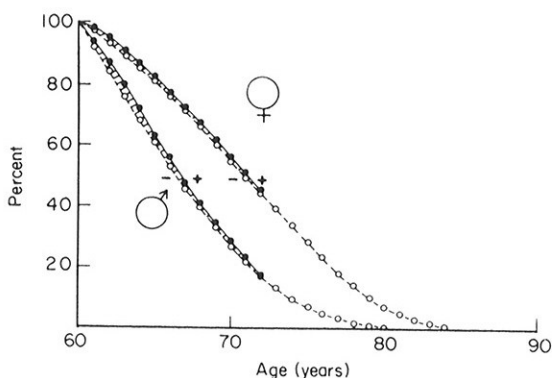


Figure 3 Survival curves for patients 60 years of age after myocardial infarction. For each sex there are two curves: —, no secondary prevention (25% continue to smoke); +, secondary prevention for two years with Timolol in $\frac{1}{3}$ of the patients.

The increase in the number of survivors will be $57\,088 - 53\,632 = 3\,456$. This will also be the total number of years of life gained per year, i.e. each treated patient will gain an average of $3456 / (6400 \times \frac{1}{3}) = 1.6$ years. As noted, this calculation assumes that both treatment and effect continue.

With regard to old age pensions, this form of secondary prevention will increase the percentage of the remaining years of life beyond 67 years of age. For male patients there will be an increase from 24 to 36%, assuming permanent treatment.

One of the beta blockers (Timolol) costs per patient about 920 NOK per year for the drug. We assume that this is the only added cost in treating the patients prophylactically, since they would in any case need regular follow-up. Thus, total cost of the drug per year would be: $920 \text{ NOK} \times 57\,088 \times \frac{1}{3} = 17\,506\,987 \text{ NOK}$ (2.3 million US \$) or 5066 NOK (675 US \$) for every year of life gained.

All these calculations assume that both treatment and effect continue beyond two years. However, current practice is to continue treatment for only two years and assume that part of the effect will continue, as suggested in Fig. 3. The number of survivors will be:

men:

$$(5120 \times \frac{1}{3} \times 7.9) + (5120 \times \frac{2}{3} \times 7.6) = 39\,424$$

women:

$$(1280 \times \frac{1}{3} \times 11.7) + (1280 \times \frac{2}{3} \times 11.5) = 14\,805$$

total

54 229

The increase in survivors will be: $54\,229 - 53\,632 = 597$ or only 17% of the potential number, if treatment were permanent (see above). Thus, treatment for two years gives:

(a) a lower gain in survivors of about 597;

(b) a lower gain in life years of about $507 / (6400 \times \frac{1}{3}) = 0.24$ years per treated patient;

(c) a lower cost, about $920 \text{ NOK} \times (2133 + 1984) = 3\,787\,640 \text{ NOK}$ (about 526 000 US \$) per year, or 6344 NOK (about 850 US \$) per year of life gained.

We conclude that the practical clinical decisions as well as the consequences for survival and costs are still uncertain beyond the first two years.

The concept of costs include more than money, e.g. side-effects. Many patients would gladly pay 920 NOK per year to postpone death, but are unable to tolerate the side-effects. The quality of life bought is important, and the quality may be reduced by drugs and by the disease itself. Most of the lives bought are in the high-risk group, and some of these patients are not fit for work^[3]. We believe that these considerations of quality of life are more important than the money involved.

This problem is further complicated by the fact that the drug must be taken by many patients to save a few. What the individual patient buys, is not life but risk reduction. Therefore, they all get the same benefit (*ex ante*). However, one could also take a different view (*post hoc*). Among 100 survivors after myocardial infarction 11 will die in the first year, and Timolol may save 3 of them. Thus, 89 would live without the drug, and 8 would die in spite of the drug; only 3 live because of the drug. This led Rose^[7] to conclude (for the first year of treatment) that one extra year of life required 30 treatment years. These figures become worse, the better the patient is: many more low-risk patients must be treated to gain a year of life. The doctor must consider this point more carefully in small infarctions, in younger patients, and in patients who have survived 1–2 years. This, apparently has led to the practice of discontinuing the treatment after 1–2 years.

Finally, we raise one point, which we call the funnel problem. Trials are always carried out in selected groups of patients. For example, the Timolol study started with 11 125 admissions for chest pain and suspected myocardial infarction. Acute myocardial infarction was proven for 4155, and 1884 patients were selected for the trial, which lasted for an average of 23 months^[2,3]. Most of these patients probably had the same underlying

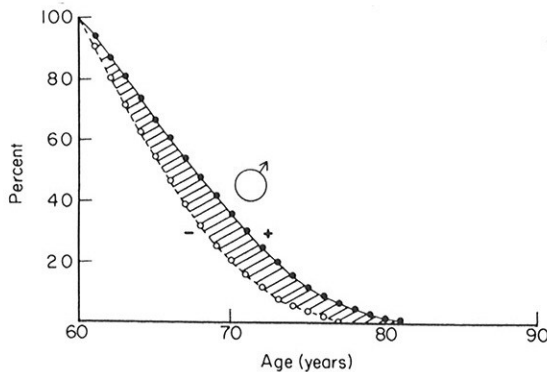


Figure 4 Survival curves for men 60 years of age after myocardial infarction. There are two curves: —, 50% continue to smoke; +, 0% continue to smoke.

disease, and the prognosis does not seem to depend on whether an infarction is demonstrated or not^[11]. Thus, when the trial is over, there is a temptation and a tendency to open up the funnel again and widen the indications and the duration of treatment. We have no solution to this problem, but it obviously influences our calculations.

To cease smoking

Smoking is an important coronary risk factor. In the Timolol study 53.3% of the patients smoked, and 23.9% still smoked at the end of one year.

Those who quit smoking have a better prognosis^[4]. In Fig. 4 we suggest what can be achieved for men, assuming that 50% of the patients smoke, that all of them either continue to smoke or are able to quit, and that the findings of Daly and coworkers^[4] are generally valid. The total mortality will decrease with about 25%. Thus, the effect is of the same order of magnitude as in secondary prevention with beta blockers, and it continues for at least 15 years^[4]. We calculate that the total number of men who survive in Norway will be:

$$\begin{aligned}
 &50\% \text{ smoke:} \\
 &\quad (5120 \times \frac{1}{2} \times 8.8) + (5120 \times \frac{1}{2} \times 6.8) = 39\,936 \\
 &0\% \text{ smoke:} \\
 &\quad (5120 \times 8.8) = 45\,056 \\
 &\text{difference} \qquad \qquad \qquad 5120
 \end{aligned}$$

Thus, if all men quit smoking, there will be 5120 more male survivors, and each smoker who quits will gain two years of life.

Secondary prevention with beta blockers and

the ceasing of smoking both reduce mortality by about 25% (by 50% for the smokers). Beta blockers give 1.6 and to cease smoking 2.0 extra years of life per patient (3.3 years to the smokers who stop). Further advantages of ceasing smoking are no costs, no side-effects, extra benefits in the form of reduced cancer risk and improved lung function, and — especially — probably a beneficial effect on the underlying vascular disease. Some of these benefits are also harvested in other trials, since some patients always quit smoking. However, they are probably equally divided between the treatment group and the placebo group.

Conclusions

We have deliberately abstained from detailed calculations and have not provided certain conclusions. The reason is not a lack of theory, but of data. However, the available data permit three general conclusions:

1. Secondary prevention will increase health services expenses and pensions. Increased production will not compensate for these increased public expenses. In economic terms, therefore, secondary prevention is a loser, or in other words: 'years of life gained' has a price to be paid like almost all other goods, and the price seems to be very modest.
2. Beta blockade is an established form of secondary prevention which saves lives and gains years of life (0.25–1.6 years). Unfortunately, the duration of the effect is uncertain, and the cut-off point at 2 years seems arbitrary.
3. To cease smoking has an effect of a similar magnitude which lasts for at least 15 years. It should be an obligatory part of secondary prevention.

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