The potential and limitations of opportunistic screening: data from a computer simulation of a general practice screening programme

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SUMMARY. Given the continuing emphasis on preventive medicine in general practice, there is considerable interest in the relative effectiveness of different ways of inviting patients to attend for screening. Recently, opportunistic methods have been advocated as being particularly useful but these methods often fail to reach a high proportion of the target population. Many patients do not consult and when they do they are not always invited to attend for screening. In this study a computer simulation model has been used to examine the effects of these variables in more detail. The notes of a random sample of 190 patients (97 women, 93 men) aged 30–50 years, registered with one general practitioner, were used to provide data for the model. The simulation model showed that increasing the number of screening appointments available each week has only a small effect on screening rates and that a ceiling is reached when 25 appointments per 1000 patients are available. In contrast, increasing the proportion of eligible consulting patients who are invited has a substantial effect such that it could take nearly 12 years to screen 90% of a target population if only one out of every four patients were invited compared with under four years if three out of every four patients were invited. The results suggest therefore that opportunistic screening methods are unlikely to achieve desired screening rates within acceptable time limits. It is argued that to achieve target levels of screening, practices will need to combine opportunistic methods with more formal methods of invitation.

Introduction

RECENT years have seen an increase in screening in general practice in the UK. This is likely to continue given the current emphasis on prevention by the government and the requirements of the new contract for general medical practitioners. It is imperative therefore that effective methods of screening practice populations be devised.

One commonly employed method has been systematic cohort screening, whereby patients are sent a postal invitation for a screening appointment. However, this method has been criticized for its poor attendance rates[1,2] and its bias in favour of the higher social classes who are seen to be less at risk — the so called 'healthy anxious'.[3,4]

The use of opportunistic screening, where patients are invited during a routine consultation to attend a screening appointment, is being advocated as a low cost, low technology means of inviting patients to preventive services in general practice.[5] Its potential is obvious given that over 90% of patients consult a general practitioner at least once every three years and over one million primary care contacts occur each day.[3]

Results obtained by the opportunistic method are, on first inspection, impressive, with subsequent attendance rates at screening in excess of 90%.[1,2] However, the overall proportion of the population screened may be disappointingly low. For example, an Oxford practice reported an attendance rate of 94% from opportunistic invitations, but only managed to screen 25% of the target population after a period of two and a half years.[2] In a study in 11 general practices in the Oxford region general practitioners were required to invite all smokers who consulted to make a screening appointment with a practice nurse.[6] Of the 2900 smokers who consulted only 751 were actually screened, while a further 109 made appointments but failed to attend. These figures produce an attendance rate of 87% but a screening rate of only 26% for the target population. Furthermore, given the low numbers screened, it is likely that those involved were the more cooperative and well-motivated patients, implying that opportunistic screening programmes which invite a greater proportion of their target population may in fact produce lower attendance rates.[2]

Studies which have looked at the ability of practices to record various behavioural risk factors suggest that those employing opportunistic screening programmes perform no better than those without a screening policy, whereas those practices with a formal screening programme show enhanced performance.[7] This has led to the suggestion that for some practices opportunistic screening may really mean that they are not doing anything.[8]

If opportunistic screening programmes are to be of any real benefit at a population level then it is imperative that the factors which limit their potential be better understood, so that their high attendance rates may be capitalized on. Opportunistic screening involves a number of steps which may prevent a patient being invited for screening and then attending. First, the patient has to visit the surgery. Secondly, the general practitioner (or another member of the primary health care team) has to invite the patient to attend for screening. This may sound obvious but the general practitioner may not have the time available in the consultation to do so, the patient may be too ill or there may not be any screening appointments available. Thirdly, once the invitation has been given the patient has to make an appointment and keep it.

Of the three steps, the first offers the least opportunity for improvement. It is simply the rate at which patients naturally consult. However, it is likely that different age–sex sub-groups consult at different rates. Similarly, given the high attendance rates already reported for opportunistic screening programmes it seems unlikely that the third step is a serious limiting factor. However, this might be improved by screening patients in the consultation, thereby obtaining a 100% attendance rate.

The second step appears to have the greatest potential for change and improvement. Two strategies present themselves. The first is to increase the number of appointments available[2] to prevent this restricting the number of patients invited, and the

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second is for the general practitioner to invite a higher proportion of consulting patients.

This paper explores these issues in more detail through the use of a computer simulation model of a general practice screening programme. More specifically, it examines the effects on target population screening rates over time of a number of factors which may inhibit opportunistic invitations being made. The two main factors considered are the number of available appointments for screening and the proportion of consulting patients who are invited for screening. In addition, the effectiveness of attempting to screen patients in the consultation is examined, as is the relative potential of opportunistic invitation methods for men and women patients.

Simulation model

A brief summary of the main components of the simulation model is given below. A more detailed description of the model and a copy of the computer software are available from the authors.

The simulation is based on the fact that if patient consultations occur at random, then the interval between each visit will have an exponential distribution, and the number of visits in a fixed interval of time will have a poisson distribution. In order to provide data for the poisson distribution the notes of a random sample of 190 patients (97 women, 93 men) aged between 30 and 50 years registered with a single general practitioner were selected. The study practice is situated in the outskirts of Sheffield has two full-time general practitioners and one part-time general practitioner with a combined list size of approximately 4300 patients. For all of the patients selected a record was made of the number of consultations made during the previous year. For those patients who had not consulted during the previous year the number of consultations over the past five years was recorded and divided by five. For each patient a mean interval between visits in weeks was obtained by dividing 52 by the number of visits recorded. In the simulation therefore, inter-visit intervals were generated for each patient from an exponential distribution with a mean appropriate to that patient.

Preliminary results from the simulation showed that the model slightly over-estimated consulting rates when compared with those reported elsewhere.[3] This may be due to the peculiar consulting patterns of the sample used for the simulation, or more likely to the fact that in the simulation every patient had a probability of consulting whereas in reality the existence of 'ghost' patients means that it is impossible for every registered patient to consult.

The approach taken in the simulation of an opportunistic screening programme was to create a series of one week bands during which a number of screening appointments could be made available. So, starting at the first one week band the simulation goes through the list of patients, searching for those patients whose next consultation is within that band. For these patients there is a probability of their being invited. A uniform random variate (0 to 1) is generated to determine whether patients are invited or not. If they are not invited, they remain in the simulation. If they are invited then the number of remaining appointments in the one week band is reduced by one. This procedure is repeated until all the available appointments have been filled, in which case no more patients are invited during that band, or until there are no more patients consulting during that band, in which case the simulation moves to the next time band. For those patients who are invited there is then the probability of their attending the screening appointment; again a uniform random variate is generated. If they do not attend they are kept in the simulation; if they do attend they are removed from the simulation and recorded as screened. This process is repeated until a desired percentage of the target population has been screened.

In the simulation three parameters were systematically varied:

1. The number of appointments available each week: 100, 50, 25, 12.5 and 6.25 appointments per week (for ease of presentation, and to act as a simple guideline for other practices, these are expressed as appointments per 1000 target patients).
2. The probability of a patient being invited at a consultation: 1.00, 0.75, 0.50 and 0.25.
3. The probability that an invited patient would attend: 1.00 (that is, screening patients in the consultation), and 0.75, which may be a realistic attendance rate to expect over the course of an opportunistic screening programme. In fact, such an attendance rate has been reported for this age–sex group in the study practice.[9]

The simulation model was constructed on the premise that consultations occur at random, and that a uniform random variate is generated when determining whether or not a patient is invited at the consultation and whether or not he attends once invited. Thus, the simulation was run 10 times for each of the possible combinations of the above variables. The results of the 10 cycles were averaged and displayed in terms of the number of weeks needed to screen increasing percentages of the target population. The simulation was run for all patients together and for men and women separately.

Results

Figure 1 shows how the performance of an opportunistic screening programme varies with the number of appointments which are made available for screening each week. The probabilities of patients being invited to attend, and their subsequent attendance, have both been set to 0.75. The relationship between the number of patients being screened and the time to screen them is not linear — as more patients are screened so the numbers coming through screening progressively decrease. This is simply the law of diminishing returns; towards the end of an opportunistic screening programme it becomes increasingly difficult to recruit patients as one is left with a greater proportion of infrequent consulters. There appears to be a marked drop-off point when around 70% of the target group have been screened. So, for example, with 12.5 appointments available each week it takes

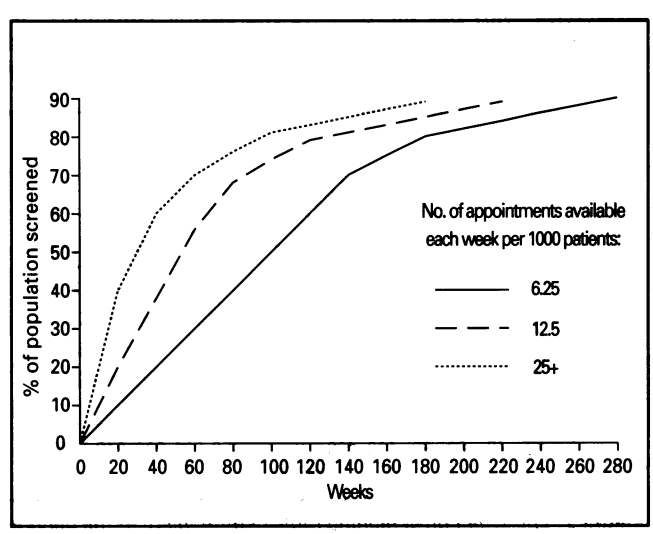

Figure 1. *The effect on screening rates of the number of appointments available with the probabilities of patients being invited for screening and of attending both set at 0.75 (n = 190 patients).*

12 weeks to increase the proportion of the target population screened from 50% to 60%, but 110 weeks to increase it from 80% to 90%.

The screening curve for 6.25 appointments per week is particularly interesting as it is linear up to 140 weeks when 70% of the target group have been screened. Thus in this early stage the number of appointments available can be seen to constrain the number of patients being screened, producing a slower but steady flow of patients through screening. After this point, the numbers being screened are constrained by the availability of patients left to invite. A similar effect can be seen, up to the 60% mark, when 12.5 appointments are made available each week for screening.

However, the constraining effect of not having enough appointments only operates up to a certain point. Thus, the performance of the simulated screening programme with 25 appointments per week was found to be virtually identical to that with 50 or 100 appointments because 25 appointments covered all the patients who might be invited. In Figure 1, therefore, 25, 50 and 100 appointments per week are represented by a single line.

Figure 2 shows how the performance of an opportunistic screening programme varies with differing probabilities that the general practitioner will invite a consulting patient for screening, with 25 appointments available each week and the probability of invited patients attending their appointments set at 0.75. The curves in Figure 2 follow the same basic pattern as those in Figure 1. The rate of increase in the proportion screened gets progressively slower over time as in Figure 1 but the range of the curves obtained is greater. It would take 152 weeks to screen 90% of the target population if every consulting patient were invited. However, if only one in every four were invited, it would take 606 weeks. It can therefore be seen that under conditions when the number of available appointments is unlikely to constrain screening rates, inviting a high proportion of consulting patients is crucial to the successful performance of an opportunistic screening programme.

Given the high attendance rates reported for opportunistic screening programmes it seems unlikely that there is room for improvement in this area. However, one strategy might be for the general practitioner to carry out screening in the consultation, making the probability of a patient attending 1.00. If every eligible consulting patient were screened in this way it would take only 110 weeks to screen 90% of the target population. However, if only one out of every two eligible consulting patients were screened in this way it would take 229 weeks to screen 90% of the target population; screening one out of every four it would take 436 weeks to achieve this level of coverage.

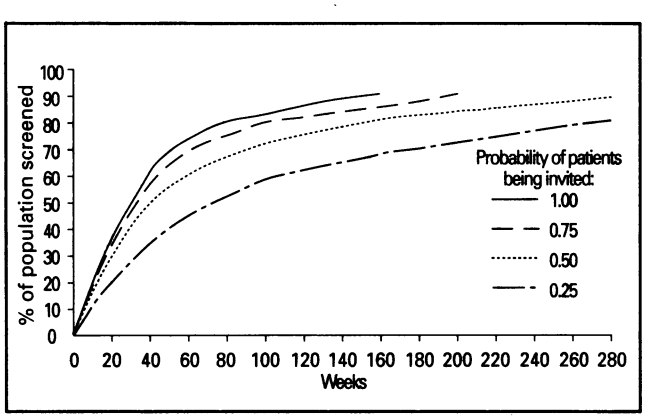

Figure 2. *The effect on screening rates of probability of the general practitioner inviting patients for screening with 25 appointments available each week per 1000 patients and the probability of patients attending set at 0.75 (n = 190 patients).*

The simulation model can also be used to illustrate differential screening effects for men and women patients. It was confirmed by the consultation data used in the simulation model that women consult, on average, more frequently than men. As a result, when the simulations of the opportunistic screening programme were run for men and women separately, without exception, women were screened at a faster rate than men. Figure 3 demonstrates the performance of an opportunistic screening programme with 25 appointments available each week and the probabilities of patients being invited and subsequently attending both set at 0.75. The differential performance is quite striking. It takes only 39 weeks to screen 70% of the women, whereas it takes twice as long (80 weeks) to screen the same percentage of men. Similarly, to screen 90% of the women takes 106 weeks, whereas it takes 267 weeks to screen the same proportion of the men.

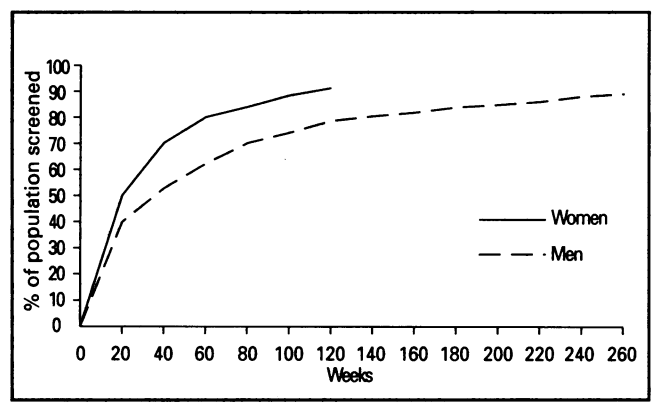

Figure 3. *Screening rates for men (n = 93) and women (n = 97) patients with 25 appointments available each week per 1000 patients and the probabilities of patients being invited for screening and of attending both set at 0.75.*

Discussion

The use of a computer simulation of an opportunistic screening programme has demonstrated the more specific implications of the factors which can limit the potential effectiveness of the programme. The simulation showed that it is difficult to maintain a steady flow of patients through such a programme. Once 60–70% of the target group has been screened, it becomes progressively more difficult to increase the percentage further as many of the more frequent consulters will have already have been screened.

In allocating resources to screening it may be desirable to obtain an even flow of patients through screening. The present data suggest that one way of achieving this is to restrict the number of screening appointments available each week to between five and 10 per 1000 patients. Increasing the number of appointments available beyond a certain level does not seem to improve the performance of an opportunistic screening programme. In the present case, there appeared to be a ceiling of 25 appointments per 1000 patients; having more appointments than this available showed no beneficial effect. In order to obtain an even flow of patients a practice may also try 'optimizing' its use of opportunistic invitations by giving priority to infrequent attenders.

The most important point arising from the simulation is that for an opportunistic screening programme to be effective it is essential that general practitioners invite a substantial proportion, if not all, of the eligible consulting patients. When the simulation was run without any constraining effects from the number of appointments available, it was found that if three

out of every four eligible patients were invited it would take under four years to screen 90% of the target population. However, if only one out of every four eligible patients were invited it would take nearly 12 years. Increasing the number of patients who are invited can be seen then to have a crucial influence on the screening rate. This will be particularly important towards the end of the screening programme when the bulk of the frequent consulters will have been invited and screened. Furthermore, this approach will be more cost effective than increasing the number of appointments available. However, it does require an organized and disciplined approach to each consultation.[3,4]

The results of actual opportunistic screening programmes which have shown high attendance rates but low screening rates[2,6] suggest that general practitioners are unable to invite a substantial proportion of consulting patients for screening. They may lack the skills or the confidence to redirect a consultation towards preventive care, they may not have the time to introduce the topic of screening, or they may feel that it is inappropriate to invite the patient at that particular time.

It could be argued that the simulation model used here represents a rather static state of affairs. In reality it is likely that practices may change the proportion of consulting patients they invite for screening as a programme goes on, so that as the numbers of patients who have yet to be screened decreases so the likelihood of their being invited increases. The model does not allow for this, but, as the simulation showed, these latter patients will always be the most difficult to reach. A missed opportunity may mean a long wait until the patient next consults.

It is likely, therefore, that even under favourable conditions an opportunistic screening programme, by itself, will be unable to screen a large enough proportion of a target population in a short enough time period to be effective. In short it will be necessary to invite certain patients by letter. This is particularly likely to be the case for men who, on the whole, tend to consult less often than women. As the simulation showed, an opportunistic screening programme will be biased in favour of women patients. This is supported by the results of an actual screening programme in which it was found that twice as many women were invited opportunistically and then screened than were men.[9]

The simulation has confirmed that inviting patients opportunistically to screening is not the ultimate solution to the problem of obtaining a high screening rate. Its potential is considerable but nevertheless limited unless a substantial proportion of eligible consulting patients are actually invited. To do this primary health care teams need to be organized[10] and ready to respond to each consultation in an effective manner.[3]

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