The price of cancer screening

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Summary

Effectiveness of a screening test is an essential but not adequate criterion for its application to patient care. The potential benefit has to be balanced against the possible harm and cost of screening. This paper presents a framework on how the price can be balanced against the benefit of cancer screening. The principles are illustrated by modelling cervical cancer and breast cancer screening programmes in the setting of Hong Kong. The estimated price for every cervical cancer death prevented by regular smear screening is 1158 women suffering from psychological harm and HK$2,277,900. The estimated price for every breast cancer death prevented by regular mammography screening is 372 women suffering from psychological harm and HK$6,249,600. Breast cancer screening is about three times more costly than cervical cancer screening but it is associated with fewer women suffering from unnecessary psychological stress. The family doctor has a duty to counsel patients on not only the potential benefit but also the cost and possible harm of a cancer screening programme, so that patients can make truly informed choices.

摘要

篩選測試的有效性是實行普查的必要條件，但並非充分條件。潛在的好處必須要和它的可能傷害和付出的代價取得平衡。本文提出一個架構說明如何平衡癌症普查的利益和代價，並以香港進行子宮頸癌和乳癌普查計劃作舉例說明其原理。為防止一名因子宮頸癌引致的死亡而實行的定期抹片測試，其估計的代價為1158名婦女蒙受心理傷害和港幣2,277,900元。為防止一名因乳癌引致的死亡而實行的定期乳房鏡檢查，其估計的代價為372名婦女蒙受心理傷害和港幣$6,249,600元。乳癌普查大約為子宮頸癌費用的三倍，但卻令較少女仕承受不必要的心理壓力。家庭醫生不單只有責任向病人說明有關癌症普查的益處，也應解釋有關的傷害和代價，使病人在有充分的資料的情況下作出選擇。

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Introduction

Cancers are the leading cause of death for both men and women in Hong Kong. They took away 11,406 lives and accounted for more than one third of all deaths in 2001.[1] Prevention is always better than cure but, unfortunately, primary prevention is still not feasible for the majority of cancers. Secondary prevention by screening so that lesions can be detected in the curable stage is the main hope for reducing cancer deaths. Needless to say, the adoption of a cancer screening programme must be based on evidence on its effectiveness in reducing mortality and not just merely increasing median survival through lead-time bias.[2] Effectiveness of a screening test is an essential but not adequate criterion for its application to patient care. Wilson and Jungner's ten criteria of screening are also applicable to cancer screening.[3] Two of them focus on the harm and cost of screening in that "the test should be acceptable with little harm or side effect" and "the cost of case-finding should be economically balanced in relation to the possible expenditure on medical care as a whole". The potential harm and the cost are the price that one has to pay for the possible benefit of a cancer screening programme.

This paper presents a framework on how the price can be balanced against the benefit of cancer screening. The principles are illustrated by modelling cervical cancer and breast cancer screening programmes in the Hong Kong setting. It is hoped that the information will help patients, health care providers and policy makers make better-informed choices.

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Effectiveness of cancer screening

Evidence on the effectiveness of cancer screening should ideally be type I in that it is based on results from proper randomised controlled trials, and at least type II in that it is supported by cohort, case controlled or comparative studies.[4] Research studies evaluating the effectiveness on cancer screening often provide data on the relative risk reduction (RRR) in cancer mortality, which may be generalisable from one population to another but does not give any information on the absolute benefit for a particular population.[5] The absolute risk reduction (ARR) is the product of the control event rate and RRR.[6] It enables the estimation of the absolute benefit in terms of "the number needed to treat (NNT)" for each cancer death prevented.[5] The ARR and NNT are population specific because they are dependent on the absolute event rate in the population concerned.[5,6]

The price of cancer screening

Although many screening testes such as cervical smears and mammographies are not associated with any significant adverse effects, the psychological harm resulting from a false positive result can be substantial.[7] Studies have shown that a positive screening result is associated with increased anxiety, depressive symptoms and subjective poor health, which often persist for many months after further investigations had excluded the disease.[8-10]

The cost of screening includes the cost of the screening tests and further investigation of false positive results.[7] The cost is greater if one takes into consideration the opportunity cost to the screened subjects but there is no agreed guideline on how this should be calculated. Therefore only the minimal cost will be considered for the purpose of this paper.

A standardised method of indicating the price of cancer screening is to express it in terms of the number needed to harm (NNH) and the cost of screening to prevent one cancer death. **Table 1** summarises the formulae for the calculation of these important indicators of a screening programme.

Cervical cancer screening by Papanicolaou smears

Screening for cervical carcinoma and intraepithelial neoplasia by regular Papanicolaou smears is regarded as the most successful cancer prevention programme so far.[11,12] Although its effectiveness has never been tested by randomised controlled trials, epidemiological data have convincingly shown marked reduction in cervical cancer mortality in countries where over 70% of the at-risk population is screened.[11,13] Day *et al* estimated that screening every three to five years could reduce cervical cancer mortality by 65 to 70%.[14] Most guidelines recommend two consecutive annual screening followed by triennial screening from the age of 25 to 65, and the benefit is expected to last until the age of 75 because it takes more than 10 years for a cervical cancer to develop.[14-18]

An estimation of ARR, NNT, false positive rate and the cost of cervical cancer screening based on the 2001 cancer mortality and incidence rates of women in Hong Kong is shown in **Table 2**.[19] Fifteen smears need to be done for each woman from the age of 25 to 65, which will total 6435 smears in order to prevent one cervical cancer death. The false positive rate of 18% was calculated from a sensitivity of 96% and a specificity of 82%,[20] and an average annual incidence of 20 cervical cancers per 100,000 women aged 25 to 65.[19] 6435 screening smears will lead to 1158 false positive results. The minimal further investigation for each false positive smear is a repeat cervical smear. The average market cost of a smear test is HK$300, so the total cost of screening per cervical cancer death prevented will be HK$2,277,900 [$300 x (6435 + 1158)].

In summary, the price for every cervical cancer death prevented by a cervical smear screening programme in Hong Kong is 1158 women suffering from unnecessary psychological harm and HK$2,277,900.

Table 1: Indicators of a cancer screening programme

RRR	=	(Death rate without screening – Death rate with screening) / Death rate without screening
ARR	=	Death rate without screening x RRR
NNT per cancer death prevented	=	1/ ARR
False positive rate	=	(1 – cancer incidence) x (1 – specificity of test)
NNH	=	NNT x number of tests per subject x false positive rate
Cost of screening	=	NNT x number of tests per subject x cost per test + NNH x cost of further investigation per false positive

Breast cancer screening by mammography

Regular mammography screening has been shown by randomised controlled trials to reduce breast cancer mortality. Meta-analysis found an overall RRR in breast cancer mortality from mammography screening of 28% for women aged 50 or over.[21] Different guidelines recommend different age limits and intervals for mammography screening but most agree to biennial screening for women aged 50 to 69.[4,22-24]

An estimation of ARR, NNT, false positive rate and the cost of breast cancer screening by mammography based on the 2001 cancer mortality and incidence rates of women in Hong Kong is shown in **Table 2**.[19] Ten mammographies need to be done for each woman from the age of 50 to 69, which will total to 7440 mammographies in order to prevent one breast cancer death. The false positive rate is 5% base on the sensitivity of 94% and specificity of 95% for mammography[25] and an average incidence of 119 breast cancers per 100,000 women aged 50 to 69.[19] 7440 screening mammographies will lead to 372 false positive results. The minimal further investigation for each false positive result is a repeat mammography. The market cost of a two-view mammography is HK$800, so the total cost of screening per breast cancer death prevented will be HK$6,249,600 [$800 x (7440 + 372)].

In summary, the price for every breast cancer death prevented by a mammography screening programme in Hong Kong is 372 women suffering from unnecessary psychological stress and HK$6,249,600. Breast cancer screening is nearly three times as costly as cervical cancer screening but it will harm fewer women psychologically.

Conclusions

Sackett pointed out in his article "The Arrogance of Preventive Medicine" that preventive care is aggressively assertive, presumptuous and overbearing.[26] This is particularly true for cancer screening that can turn subjectively healthy people into patients with a life threatening disease. The potential benefit must be balanced against the possible psychological harm and cost. It is important for family doctors to remind ourselves and our patients that the majority of people undergoing cancer screening may never benefit from the prevention of cancer death but a significant proportion may have to bear unnecessarily the stress from a false positive result.[27] Adequate counselling of the patient before and after the screening test may reduce the psychological impact.[28]

It is not possible to judge what the price for the prevention of a cancer death should be, and different people may be willing to pay different prices. The role of the family doctor is to help each patient make a truly informed choice by an honest disclosure of the balance sheet.

Table 2: The price and benefit of cervical and breast cancer screening programmes

	Cervical cancer aged 25-75	Breast cancer aged 50-69
Cumulative mortality rate	359 / 100,000	480 / 100,000
RRR	65%	28%
ARR	(359 x .65) / 100,000 = 233.35 / 100,000	(480 x .28) / 100,000 = 134.4 / 100,000
NNT per Death prevented	100,000 / 233.35 = 429	100,000 / 134.4 = 744
Total no. screening tests	429 x 15 = 6435	744 x 10 = 7440
Cancer incidence	20 / 100,000	119 / 100,000
Sensitivity / Specificity	96% / 82%	94% / 95%
False positive rate	18%	5%
NNH per Death prevented	1158	372
Cost per Death prevented	HK$2,277,900	HK$6,249,600

Key messages

1. The potential benefit has to be balanced against the possible harm and cost of screening.
2. The absolute risk reduction (ARR) and the number needed to treat (NNT) are better indicators of the absolute benefit of screening.
3. A positive screening result is associated with increased anxiety, depressive symptoms and subjective poor health.
4. The minimal cost of screening includes the cost of the screening tests and further investigation of false positive results.
5. Adequate counselling of the patient before and after the screening test may reduce the psychological harm.
6. Breast cancer screening is about three times the cost of cervical cancer screening but it is associated with fewer women suffering from unnecessary psychological stress.

We have modelled the cervical cancer and breast screening programmes in the setting of Hong Kong based on overseas data on effectiveness and recommended international screening protocols because local data are not available. Studies have shown that RRR of screening are similar in different populations,[14,21] and sensitivity and specificity of a test are generalisable because they are intrinsic properties of the test. Therefore, the estimation of the price of the screening programmes described in this paper represents the best available evidence for our population until empirical data based on screening programmes in Hong Kong are available. ■

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