

Original Article

Cost-Effectiveness Analysis of Colorectal Cancer Screening Methods in Iran

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Abstract

Introduction: Screening can prevent colorectal cancer from becoming advanced by early detection of precancerous lesions. Cost-effectiveness analysis of colorectal cancer screening methods is highly necessary due to increased prevalence, decreased age at onset and the limited budget in Iran.

Methods: Methods of screening currently available in Iran were selected. A systematic search revealed the sensitivity and specificity of each method. For this study, a model for a 20 year screening period of a population of 100000 apparently healthy persons of ages 45 – 65 years in Isfahan Province was used. The cost-effectiveness of each method and the ratio of cost-effectiveness were calculated based on this model.

Results: The most and the least effective methods were CT colonography and fecal occult blood test, respectively. The highest and lowest expenditures in the governmental sector were related to fecal occult blood test and flexible sigmoidoscopy and in the private sector, to CT colonography and fecal occult blood test, respectively. The cost per cancer detected in 20 years of screening in the governmental sector was 0.28, 0.22 and 0.42 billion Rials, respectively for screening by colonoscopy, flexible sigmoidoscopy and fecal occult blood test. In the private sector, these were 1.54 (colonoscopy), 1.68 (flexible sigmoidoscopy), and 1.60 (fecal occult blood test) billion and 2.58 billion Rials for CT colonography, respectively.

Conclusion: Although CT colonography is the most effective method, it needs a budget of 2.58 billion Rials for each screened patient. If costs in the governmental sector are considered, flexible sigmoidoscopy would be the most cost-effective method for screening the 45 – 65-year-old population in Iran.

Keywords: colorectal cancer, cost-effectiveness, Iran, screening

Introduction

Colorectal cancer is increasing in Iran.¹⁻⁶ This cancer is treatable in most patients if diagnosed in its early stages,⁷⁻⁸ when asymptomatic. Screening for colorectal cancer within high risk populations is encouraged.¹⁻⁶ In Iran colonoscopy, sigmoidoscopy, CT colonography (CTC), barium enema and fecal occult blood tests (FOBT) are the available methods for screening colorectal cancer. Among these, colonoscopy and sigmoidoscopy can directly detect the cancer and have the ability to remove the precancerous lesions at the time of screening. However it is not known if we can use these methods for mass screening of patients. It is obvious that the most effective method is the one that can detect more cancerous lesions in patients, but for determining the most suitable method it is not enough. The best method should have the least cost-effectiveness (C/E) ratio; in other words, more patients should be detected with less cost. In this study, the C/E ratios of the methods of

screening for colorectal cancer in Iran have been calculated and the best method selected. In calculating the C/E ratios of these methods in Iran, some epidemiologic aspects of colorectal cancer were considered.

Materials and Methods

The methods colonoscopy, flexible sigmoidoscopy (FS), CTC and FOBT were selected for comparison. To determine the C/E analysis of these methods, the costs and effectiveness of each method were calculated separately.

Measuring effectiveness

In order to measure the effectiveness of each method, initially the sensitivity and specificity of the methods were confirmed. For this purpose, a systematic literature review was performed. The method for this systematic review is discussed in another article currently under publication.

Modeling

A model for comparing four screening tests was made. The target population in this model consisted of 100000 apparently healthy people that were in the high risk group (over 45 years old). Therefore, screening was modeled to be completed on 45 – 65 year olds. The population in Isfahan Province was selected for this study as a representative Iranian

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sample because the pattern of colorectal cancer in Iran is approximately the same in all provinces.⁹ The rate of patients diagnosed through screening with each method was considered as the effectiveness of the method. This percent was calculated according to the prevalence of this cancer in Iran and the sensitivity and specificity of each method determined through systematic searching. The number of true positive or negative; and false positive or negative people were calculated based on this model. The false or true negative groups were not involved in the latter courses of screening. The period for screening was considered as 20 years.

Measuring costs

In this study the direct costs of screening with each method was considered. For calculating the costs, first the stages of performing each method and subsequently the cost of each stage were determined. Summing these costs revealed the overall cost for one course of screening. Considering the different costs between the public and private sectors in Iran, the costs of screening in each sector were separately calculated. For measuring the overall costs of each method, the following formula was used:

$$\begin{aligned} \text{Overall costs} = & \\ & (\text{the cost of a single test} \\ & \times \text{number of tests that should be done in 20 years}) \\ & + (\text{cost of colonoscopy per patient} \\ & \times \text{number of colonoscopies that should be done in 20 years}) \end{aligned}$$

When CTC, FOBT and FS results are positive, the diagnosis of colorectal cancer should be confirmed or disproved with colonoscopy.

Measuring the cost-effectiveness ratio

Once the effectiveness and cost for each method were measured, the C/E ratio for each method was calculated. The least C/E ratio revealed the best C/E method.

Results

Systematic review

A systematic review of the literature was performed in PubMed, Cochrane Library, and CRD database. The sensitivities and specificities of each method are presented in Table 1.

Sensitivity and specificity of flexible sigmoidoscopy (FS)

FS is an instrument that can examine both the rectum and a portion of the colon. The reported sensitivity of FS (per the literature) pertains to the specific part of the colon detected with this method. Therefore, in order to calculate the true sensitivity of FS, the sensitivity as reported in the literature should be multiplied by the percent of lesions located in the specific regions as visualized by FS.

Measuring effectiveness

The following model was used to measure the effectiveness of each method:

- 1 → disease prevalence
- 2 → 1 disease prevalence
- 3 → sensitivity
- 4 → 1 sensitivity
- 5 → specificity
- 6 → 1 specificity

N1 → represents the screening target population (100000 apparently healthy patients, ages 45 – 65 years)

Table 1. Result of the mean sensitivities and specificities of each method according to the systematic review.

Method of screening	Sensitivity (%)	Specificity (%)
Colonoscopy	95±4.25	100
Sigmoidoscopy	58.8±7.6	93±1.4
CT colonography	80±13.6	88±11.9
Fecal occult blood test	32.5±12.5	89±8.1

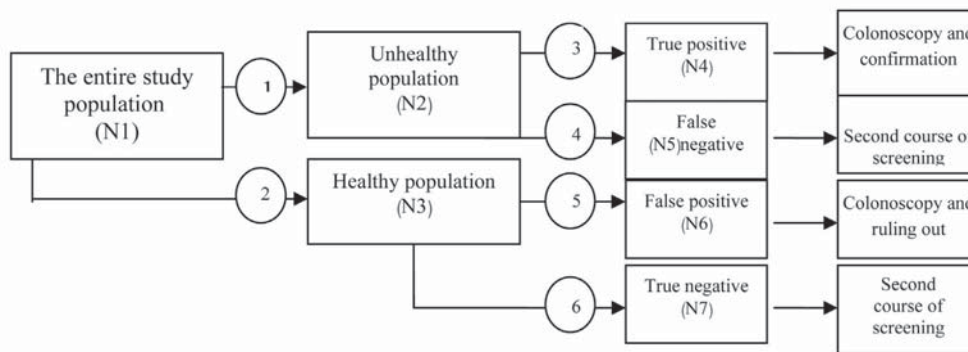


Table 2. Effectiveness of each screening method.

Method	Number of patients detected per 100000 population	Number of patients undetected in screening	Number of colonoscopies performed in 20 years	Number of tests that should be done in 20 years
Fecal occult blood test	201.36	328.64	87831.60	791497.37
Flexible sigmoidoscopy	274.92	255.08	25420.85	359695.25
CT colonography	289.38	240.62	40245.60	333330.28
Colonoscopy	252.95	277.05	0	199974.82

Table 3. The costs of drugs used for screening purposes.

Drug name	Cost (Rials)	Drug name	Cost (Rials)
Lidocaine gel	2300	Bisacodyl tablets (5 mg)	420
Serum set	2160	Pidrolax box	9500
Branule	6600	Normal saline serum (1 liter)	8500
Barium sulfate powder	10000	Midazolam injection (5 mg)	2500
Hyoscin tablet	500	Pethidin injection	7120

Table 4. The costs of screening methods.

Method	Cost in public sector	Cost in private sector
Colonoscopy	259000	1800000
Flexible sigmoidoscopy	55500	1100000
CT colonography	—*	1870000
Fecal occult blood test	15000	48000

*This method is not available in the public sector

Table 5. The cost of physician visits.

Physician	Cost in public sector (Rials)	Cost in private sector (Rials)
Fellowship physician	35000	88000
Gastroenterologist	28000	77000
General physician	23500	47000

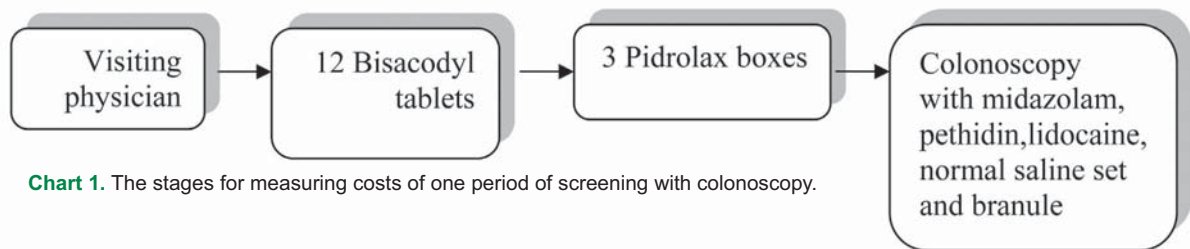


Chart 1. The stages for measuring costs of one period of screening with colonoscopy.

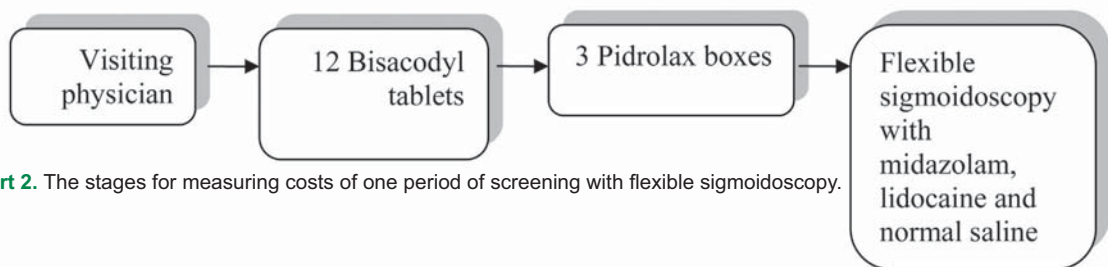


Chart 2. The stages for measuring costs of one period of screening with flexible sigmoidoscopy.

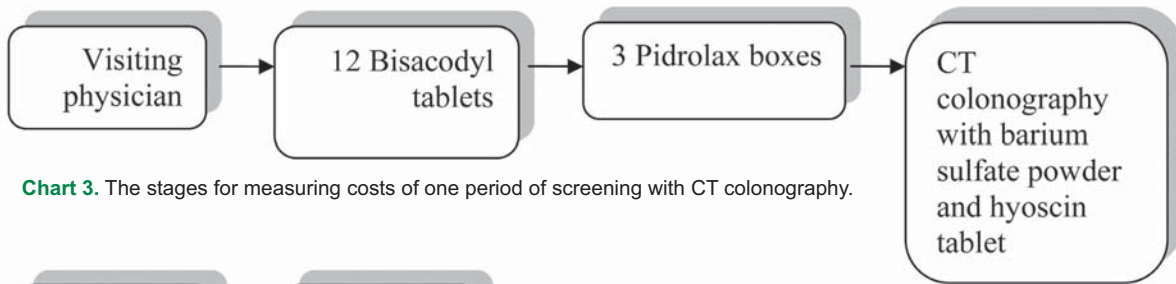


Chart 3. The stages for measuring costs of one period of screening with CT colonography.

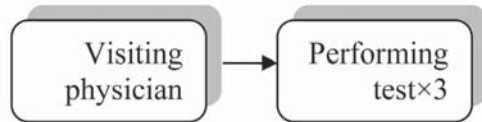


Chart 4. The stages of measuring costs of one period of screening with FOBT.

Table 6. Cost comparison between methods of one period of screening.

Method	Cost in public sector (Rials)	Cost in private sector (Rials)
Colonoscopy	357680	1951680
Flexible sigmoidoscopy	147060	1144560
CT colonography	—	2003000
Fecal occult blood test	68500	191000

The effectiveness is the number of true positive patients in 20 years of screening. Colonoscopies are recommended to be performed every ten years; therefore patients should have colonoscopies during the first and tenth years. FS and CTC would be performed during the first, fifth, tenth, and fifteenth years whereas FOBT should be done annually from the first to the nineteenth years.

Table 2 shows the results of the effectiveness of each method of screening.

Measuring costs

The costs of medicines and services are used before, during and after screening are presented in Tables 3, 4, and 5.

Measuring overall costs in one period of screening with each

method

The following charts 1 to 4 show the overall costs in one period of screening with each method.

The costs of performing one period of screening with each method are presented in Table 6.

The overall costs for each method of screening over a 20-year period were calculated with the following formula:

$$\begin{aligned} \text{The overall cost} &= (\text{The number of tests that should be performs over 20 years} \\ &\times \text{cost of one period of screening}) \\ &+ (\text{number of patients that should undergo colonoscopy} \\ &\times \text{cost of colonoscopy for each person}) \end{aligned}$$

Table 7. Costs, effectiveness and C/E ratios of screening with each method.

Screening method	Effectiveness (true positives per 100000 population over 20 years of screening)	Overall costs (billion Rials)	C/E ratio (billion Rials per patient detected through screening)
Colonoscopy	252.95	Public sector 71.53	0.28
		Private sector 390.29	1.54
Flexible sigmoidoscopy	274.92	Public sector 61.99	0.22
		Private sector 461.31	1.68
CT colonography	289.38	Private sector 746.21	2.58
Fecal occult blood test	201.36	Public sector 85.63	0.42
		Private sector 322.60	1.60

Measuring cost-effectiveness ratio

In order to measure the cost-effectiveness ratio for each method, the following formula was used:

$$\text{Cost - effectiveness ratio} = \frac{\text{The overall costs}}{\text{The overall effectiveness}}$$

The overall effectiveness is considered as the number of patients detected in 20 years of screening with each method (true positive patients).

Costs, effectiveness and C/E ratios of screening with each method are presented in Table 7.

Discussion

Although CT colonography is the most effective method, it is not recommended for mass screening in Iran. The most C/E method is the one with the least C/E ratio, therefore in the public sector, FS is the most C/E method for screening the 45 – 65-year-old population in Iran. In the private sector, FOBT is the best.

In Iran, colorectal cancer is more commonly located in the distal parts of the colon¹ and this may justify the recommendation of FS. In populations where greater than 70% of colorectal cancer is seen in the terminal parts of the colon, Flexible sigmoidoscopy is recommended as the method of

choice for screening.¹⁰ In this study, the data regarding compliance for each method of screening in Iran was not available, thus the tests that are recommended are not necessarily the best methods. Hence further studies should be done to determine the best method.

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