

## Feasible economic strategies to improve screening compliance for colorectal cancer in Korea

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### Abstract

**AIM:** While colorectal cancer (CRC) is an ideal target for population screening, physician and patient attitudes contribute to low levels of screening uptake. This study was carried out to find feasible economic strategies to improve the CRC screening compliance in Korea.

**METHODS:** The natural history of a simulated cohort of 50-year-old Korean in the general population was modeled with CRC screening until the age of 80 years. Cases of positive results were worked up with colonoscopy. After polypectomy, colonoscopy was repeated every 3 years. Baseline screening compliance without insurance coverage by the national health insurance (NHI) was assumed to be 30%. If NHI covered the CRC screening or the reimbursement of screening to physicians increased, the compliance was assumed to increase. We evaluated 16 different CRC screening strategies based on Markov model.

**RESULTS:** When the NHI did not cover the screening and compliance was 30%, non-dominated strategies were colonoscopy every 5 years (COL5) and colonoscopy every 3 years (COL3). In all scenarios of various compliance rates with raised coverage of the NHI and increased reimbursement of colonoscopy, COL10, COL5 and COL3 were non-dominated strategies, and COL10 had lower or minimal incremental medical cost and financial burden on the NHI than the strategy of no screening. These results were stable with sensitivity analyses.

**CONCLUSION:** Economic strategies for promoting screening compliance can be accompanied by expanding insurance coverage by the NHI and by increasing reimbursement for CRC screening to providers. COL10 was a cost-effective and cost saving screening strategy for CRC in Korea.

### INTRODUCTION

Korea is known to be a low-risk area for colorectal cancer (CRC), but the incidence has been rapidly increasing during the last decade. From 1987 to 1996, the age-standardized mortality rate for CRC has roughly doubled from 8.7 to 16.5 per 100 000 for men and 6.3 to 14.3 per 100 000 for women<sup>[1]</sup>. Screening for CRC reduces mortality through detection of malignancy at an earlier, more treatable stage as well as by identification and removal of precursor lesion, the adenomatous polyp<sup>[2]</sup>. Recent panel in Korea recommends that an average-risk individual should begin CRC screening at the age of 50 with one of the two following guidelines<sup>[3]</sup>: 1. Colonoscopy (COL) every 5-10 years. 2. Flexible sigmoidoscopy (SIG) and double-contrast barium enema (DCBE) every 5 years.

However, these recommendations condoned by expert panels, were not based on economic evaluation. CRC screening tests vary considerably in terms of their performance characteristics, complication rates, acceptability and cost. Especially the cost structure for reimbursement of CRC screening and treatment in Korea is different from that in other countries. Colonoscopy, sigmoidoscopy and DCBE for CRC screening are not covered by national health insurance (NHI) scheme in Korea. Previous studies have demonstrated that out-of-pocket payment was a barrier to cancer screening and health insurance was an important determinant of the utilization of cancer screening<sup>[4,5]</sup>. In addition, physician's noncompliance with screening recommendation was known to be a major barrier to effective CRC control<sup>[6]</sup>. Perceived inadequacy of the reimbursement of colonoscopy or sigmoidoscopy was one of the factors affecting physician's compliance<sup>[7]</sup>.

To improve the physician and patient compliance for CRC screening, some reports have demonstrated that the third-party payer should remove financial barriers by providing insurance coverage and raising reimbursement of CRC screening to physicians<sup>[8]</sup>. However, Korean NHI

has experienced an annual deficit since 1997 and fiscal stability is a major concern<sup>[9]</sup>. At the current status, new national policy on screening should not put financial burden on the Korean NHI system and needs to take into account economic consequences.

To suggest a feasible economic model to improve the compliance by raising insurance coverage and reimbursement without increasing financial burden on the NHI, we constructed a decision-analytic model to evaluate the cost-effectiveness of CRC screening for average-risk Korean individuals.

## MATERIALS AND METHODS

### Model

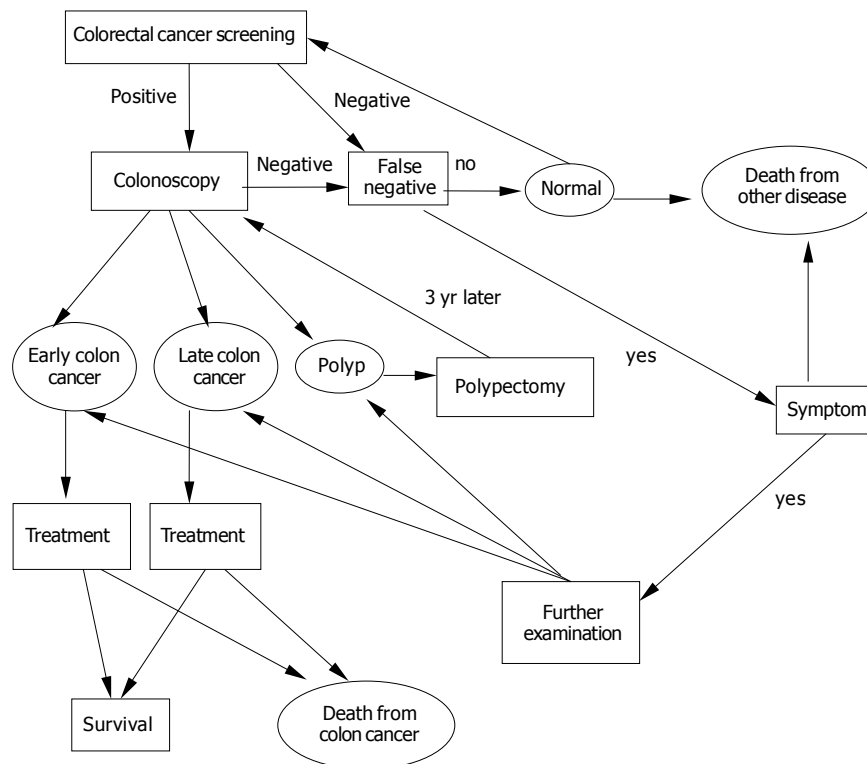
The natural history of a simulated cohort of 50-year-old Koreans in the general population was modeled with and without CRC screening until the age of 80 years (Figure 1). We evaluated 16 different screening strategies with Markov model. Persons representative of the 50-year-old Korean population were placed into health states defined by the presence or absence of a polyp or cancer (early or advanced). Cases of positive screening test results were worked up with a colonoscopy, and individuals diagnosed with polyp underwent polypectomy. Colonoscopy was repeated every 3 years for surveillance after polypectomy<sup>[10]</sup>. The probability of perforation was assigned to DCBE, SIG, COL and polypectomy<sup>[11-13]</sup>. Mortality caused by the risk of perforation was assumed to be 0.02%<sup>[13,14]</sup>.

Our main outcome measures were discounted lifetime

costs, life expectancy, lifetime NHI's financial burden and incremental cost-effectiveness ratio (ICER), which were compared for 16 different CRC screening strategies. Incremental cost-effectiveness analysis was performed by ranking the 16 strategies in the order of increasing effectiveness. After eliminating strategies, that were more or equally costly and less effective than a competing strategy (i.e., ruled out by simple dominance), we calculated the ICER for each strategy (additional cost divided by additional benefit) compared with the next least expensive strategy. If a strategy was less effective and had a higher ICER than another strategy, it was ruled out by extended dominance<sup>[15]</sup>. Strategies exhibiting extended dominance were eliminated from the rank-ordered list, and ICERs of the remaining strategies were recalculated. Future costs and life-years were discounted at an annual rate of 3%. The model was programmed in DATA Pro 4.0 software (TreeAge Software Inc., Williamstown, MA).

### Clinical data

**Natural history of colorectal polyps and cancer** Table 1 showed selected parameter estimates. We estimated the age-specific prevalence of adenomatous polyps from previous studies in Korea<sup>[3,16]</sup>. The incidence of polyp is assumed to be constant calibrated with the two prevalence rates between age 50 and 65. The probability of transformation from polyp to cancer was estimated from the study of patients who refused the resection of polyp<sup>[17]</sup>. We assumed that the longer the duration of polyp, the greater the probability of transformation from polyp to cancer.



**Figure 1** Markov model of colorectal cancer screening. The ovals represent Markov states in which patients remain for at least full 1-year cycle. The squares represent intermediate states of screening procedures, in which patients may enter and leave during one cycle. The arrows represent transitions between various states.

**Table 1** Summary of assumption

	Parameter	Base case value	Reference	
Sensitivity and specificity of screening and diagnosis	Sensitivity of FOBT for polyps/cancer	0.1/0.5	[15], [28], [29], [30]	
	Sensitivity of colonoscopy for polyps/cancer	0.85/0.97	[2], [31], [32]	
	Sensitivity of colon study for polyps/cancer	0.5/0.8	[2], [33], [34]	
	Sensitivity of sigmoidoscopy for polyps/cancer	0.67	[1], [2], [31], [32]	
	Specificity of FOBT	0.9	[15], [28], [29], [30]	
	Specificity of colonoscopy	1	[2], [31], [32]	
	Specificity of colon study	0.9	[2], [33], [34]	
	Specificity of sigmoidoscopy	1	[2], [31], [32]	
	Natural history of polyp/cancer sequence	Prevalence of polyps at age 50	0.25	[13], [36]
		Annual polyp incidence rate	0.005	[13], [36]
Percent of cancers originating as polyps		100%	[37], [38]	
Annual cancer incidence of polyp whose duration is below 5 yr		0.005	[17], [39], [40], [41]	
Annual cancer incidence of polyp whose duration is from 5 to 10 yr		0.01	[17], [39], [40], [41]	
Annual cancer incidence of polyp whose duration is above 10 yr		0.016	[17], [39], [40], [41]	
Dwelling time of cancer in early stages		2 yr	[29], [42]	
Percent of cancers detected in early stages with no screening		5%	[21]	
Five-year all cause survival for early cancer		90%	[21], [20]	
Five-year all cause survival for advanced cancer		54%	[20], [21], [23]	
Polyp recurrence rate after polypectomy in the first year		0.11	[2], [3]	
Polyp recurrence rate after polypectomy thereafter		0.03	[2], [3]	
Complications and unintended consequences		Rate of perforation of colon in colonoscopy	0.002	[12], [13]
		Rate of perforation of colon in polypectomy	0.004	[12], [13]
	Rate of perforation from sigmoidoscopy	0.0001	[12], [13]	
	Rate of perforation from colon study	0.00005	[7]	
	Death rate from perforated colon	0.002	[16], [17]	
	Cost (won <sup>1</sup> )	Sigmoidoscopy	26 620	[24]
Colonoscopy		52 560	[24]	
Colon study		58 600	[24]	
FOBT		2 290	[24]	
Polypectomy		134 600	[24]	
Biopsy		24 160	[24]	
Treatment of early cancer for first year		5 150 000	[3], [17], [23]	
Treatment of advanced cancer for first year		10 300 000	[3], [17], [23]	
Treatment of cancer after first year		2 164 000	[3], [17], [23]	
Treatment of colonic perforation		3 000 000	[3]	

<sup>1</sup>Exchange rate: 1200 Korean won for one US dollar.

We defined early stage cancer as modified Duke's stage A and advanced stage as modified Duke's stage B-D<sup>[18,19]</sup>. The latent period between early stage and advanced stage was assumed to be 2 years<sup>[14]</sup>. The stage-specific CRC mortality was applied uniformly to all malignancies, regardless of the means of detection (by symptoms or screen) or the state of detection (diagnose *vs* undiagnose cancer). Five-year survival rates from previous studies were used for the yearly probability of dying from CRC based on the stage and number of years with cancer<sup>[20,21]</sup>. Age-specific mortality from other causes was estimated, based on the above source combined with statistics published by the National Center for Health Statistics<sup>[22]</sup>.

### Cost

We obtained the data on the costs of CRC treatment by stage and time period from the National Health Insurance Corporation (social insurer of the NHI with a universal coverage of population)<sup>[23]</sup>. However, the co-payment that patients pay at the point of service amounts to about 50% of the total medical expenses of CRC treatment in Korea<sup>[3,9]</sup>. Therefore, the total medical cost of CRC treatment was assumed to be twice the expense that the NHI reimburses. Costs of screening test were obtained from the fee schedule of the National Health Insurance Corporation (the NHI of Korea has a fee schedule applied to all insured services)<sup>[24]</sup>.

### Compliance and screening cost

Compliance rates of 50-70% were obtained in the optimized setting of clinical trials of CRC screening<sup>[2]</sup>. However, colonoscopy, sigmoidoscopy and DCBE for CRC screening are not covered by the NHI in Korea. Therefore, the compliance is likely to be lower than that in other countries where CRC screening is covered by health insurance. At each particular screening event without NHI benefit coverage, we assumed that 30% of population underwent the initial screening test, independent of whether they were compliant with past tests. The compliance of follow-up or surveillance colonoscopy was assumed to be 20% higher than that of the initial screening.

If the NHI covered the CRC screening or the amount of reimbursement for screening to providers increased, the compliance was assumed to increase. If the NHI covered 50% and 100% of screening cost, the compliance was assumed to be 15% and 30% higher than that in case of non-coverage respectively, by reducing the financial barrier of patients. The Korean Medical Association had insisted that current reimbursement of colonoscopy to physicians was too low and the appropriate level should be 60% higher than the current level<sup>[25]</sup>. An increase in colonoscopy reimbursement, to 60% higher than the current level, was assumed to lead to 10% increase in the compliance due to financial incentives for physicians.

As there were no data available on the compliance changes resulting from the change in insurance coverage or reimbursement level, we performed sensitivity analysis to assess the stability of the results to plausible ranges of compliances. The compliance rate was set to vary from 10% lower to 10% higher than the baseline value.

## RESULTS

In the base-case analysis at 30% screening compliance without NHI coverage, all screening strategies extended life expectancy. And the strategies which were not ruled out by simple dominance or extended dominance (non-dominated

strategies) were colonoscopy every 5 years (COL5) and colonoscopy every 3 years (COL3). The screening strategies with colonoscopy or sigmoidoscopy showed lower total medical cost and lower financial burden on the NHI than the strategy of no screening (Table 2).

If the NHI covered 50% of the screening cost and the screening compliance was 45%, non-dominated strategies were colonoscopy every 10 years (COL10), COL5 and COL3. As the coverage of NHI increased, the financial burden on NHI increased. Nevertheless, the financial burden on the NHI associated with COL10 was smaller than that associated with no screening (Table 3). In the case that NHI covered 100% of screening cost, non-dominated strategies

**Table 2 Cost-effectiveness of 16 strategies of colorectal screening among Korean adults without NHI coverage (NHI<sup>a</sup> coverage = 0%, screening compliance = 30%, follow-up compliance = 50%)**

Strategy (abbreviation)	Lifetime cost per person, won <sup>2</sup>	Life expectancy, cost per day	Incremental person, won <sup>2</sup>	Incremental days of life gained	Lifetime financial burden of NHI <sup>1</sup> , won <sup>2</sup>	Incremental C/E <sup>3</sup> , won <sup>2</sup> per life-year gained
COL5	311 682	6 176.1			139 043	
COL3	313 877	6 181.1	2 195	5.0	128 757	160 965
COL10	321 407	6 171.7	7 530		151 394	(Dominated) <sup>4</sup>
COL at 55	336 367	6 167.9	22 490		164 547	(Dominated)
SIG3	346 903	6 172.4	33 026		155 607	(Dominated)
SIG5	352 290	6 167.9	38 413		164 996	(Dominated)
SIG10	356 222	6 165.8	42 345		171 689	(Dominated)
SIG at 55	359 939	6 164.4	46 062		177 231	(Dominated)
SIG5+DCBE5	368 560	6 168.1	54 683		165 557	(Dominated)
No screening	370 726	6 161.9	56 849		185 236	(Dominated)
FOBT2	375 772	6 165.5	61 894		187 015	(Dominated)
FOBT1+SIG5	384 709	6 169.7	70 832		187 443	(Dominated)
FOBT1	387 912	6 168.1	74 035		192 309	(Dominated)
DCBE10	390 767	6 164.1	76 890		177 826	(Dominated)
DCBE5	410 554	6 165.3	96 677		174 392	(Dominated)
DCBE3	435 775	6 169.3	121 898		169 661	(Dominated)

COL, colonoscopy; SIG, sigmoidoscopy; DCBE, double contrast barium enema; FOBT, fecal occult blood test. Ellipses indicate no data (incremental days or life gained and incremental CE ratio were not calculated for these strategies because they were dominated or extended dominated). <sup>1</sup>National Health Insurance of Korea. <sup>2</sup>Exchange rate: 1200 Korean won for one US dollar. <sup>3</sup>Incremental CE ratio (won/year) = Incremental cost per person/Incremental days of life gained×365 d. <sup>4</sup>Dominated strategy is a strategy that is more or equally costly and less effective than a competing strategy.

**Table 3 Cost-effectiveness of 16 strategies of colorectal screening among Korean adults with changing NHI<sup>1</sup> coverage and compliance**

Strategy (abbreviation)	Lifetime cost per person, won <sup>2</sup>	Lifetime financial burden of NHI <sup>1</sup> , won <sup>2</sup>	Incremental C/E <sup>3</sup> , won <sup>2</sup> per life-year gained	Strategy (abbreviation)	Lifetime cost per person, won <sup>2</sup>	Lifetime financial burden of NHI <sup>1</sup> , won <sup>2</sup>	Incremental C/E <sup>3</sup> , won <sup>2</sup> per life-year gained
NHI <sup>1</sup> coverage = 50% Screening compliance = 45%, Follow-up compliance = 65%				NHI <sup>1</sup> coverage = 100% Screening compliance = 60%, Follow-up compliance = 80%			
COL10	310 354	178 233		COL10	307 395	226 848	
COL5	311 640	188 051	93 440	COL at 55	308 933	192 405	(Dominated)
COL at 55	321 624	172 824	(Dominated) <sup>4</sup>	SIG5	316 541	235 951	(Dominated)
SIG3	328 365	197 511	(Dominated)	SIG10	321 728	214 095	(Dominated)
SIG5	332 244	191 881	(Dominated)	SIG3	323 691	261 056	(Extended Dominated) <sup>5</sup>
COL3	336 101	207 072	2 113 350	COL5	325 435	267 054	1 371 670
SIG10	339 760	186 587	(Dominated)	SIG at 55	330 560	191 573	(Dominated)
SIG at 55	347 179	181 334	(Dominated)	FOBT2	370 827	216 521	(Dominated)
SIG5+DCBE5	369 225	213 205	(Dominated)	No screening	370 968	185 809	(Dominated)
No screening	370 847	185 499	(Dominated)	COL3	374 192	323 357	5 656 770
FOBT2	373 988	208 794	(Dominated)	FOBT1+SIG5	382 870	277 687	(Dominated)
FOBT1+SIG5	380 512	238 067	(Dominated)	SIG5+DCBE5	383 934	303 581	(Dominated)
FOBT1	388 456	234 316	(Dominated)	FOBT1	389 668	248 595	(Dominated)
DCBE10	394 938	209 420	(Dominated)	DCBE10	397 017	260 523	(Dominated)
DCBE5	420 550	229 974	(Dominated)	DCBE5	429 376	316 022	(Dominated)
DCBE3	455 758	255 914	(Dominated)	DCBE3	478 144	384 805	(Dominated)

COL, colonoscopy; SIG, sigmoidoscopy; DCBE, double contrast barium enema; FOBT, fecal occult blood test. <sup>1</sup>National Health Insurance of Korea. <sup>2</sup>Exchange rate: 1 200 Korean won for one US dollar. <sup>3</sup>Incremental CE ratio (won/year) = Incremental cost per person/incremental days of life gained×365 d. <sup>4</sup>Dominated strategy is a strategy that is more or equally costly and less effective than a competing strategy. <sup>5</sup>Extended dominated: Extended dominated strategy is a strategy which is less effective and had a higher ICER than another strategy.

**Table 4** Cost-effectiveness of 16 strategies of colorectal screening among Korean adults with raising reimbursement of colonoscopy to 60% higher than current level (Cost of colonoscopy = 85 000 won<sup>1</sup>, NHI<sup>2</sup> coverage = 50% screening compliance = 55%, follow-up compliance = 75%)

Strategy (abbreviation)	Lifetime cost per person, won <sup>1</sup>	Life expectancy, day	Lifetime financial burden of NHI <sup>2</sup> , won <sup>1</sup>	Incremental C/E <sup>3</sup> , won <sup>1</sup> per life-year gained
COL at 55	339 486	6 173.1	184 815	
SIG at 55	353 851	6 169.0	182 912	(Dominated) <sup>4</sup>
COL10	362 230	6 179.1	208 801	1 401 600
SIG10	364 257	6 173.3	192 838	(Dominated)
No screening	371 238	6 161.9	185 704	(Dominated)
SIG5	377 039	6 178.0	201 390	(Dominated)
FOBT2	384 067	6 170.8	219 587	(Dominated)
SIG3	399 919	6 183.0	210 271	(Extended dominated) <sup>5</sup>
COL5	402 824	6 184.0	238 433	2 992 270
FOBT1	409 771	6 176.2	254 521	(Dominated)
DCBE10	410 690	6 169.1	221 430	(Dominated)
FOBT1+SIG5	426 305	6 180.8	262 952	(Dominated)
SIG5+DCBE5	435 850	6 178.8	235 034	(Dominated)
DCBE5	448 356	6 173.0	249 784	(Dominated)
COL3	474 893	6 187.5	281 257	7 487 245
DCBE3	499 560	6 178.5	284 941	(Dominated)

COL, colonoscopy; SIG, sigmoidoscopy; DCBE, double contrast barium enema; FOBT, fecal occult blood test. Current level of colonoscopy cost in Korea is about 53 000 won. <sup>1</sup>Exchange rate: 1 200 Korean won for one US dollar. <sup>2</sup>National Health Insurance of Korea. <sup>3</sup>Incremental CE ratio (won/year) = incremental cost per person/incremental days of life gained×365 d. <sup>4</sup>Dominated strategy is a strategy that is more or equally costly and less effective than a competing strategy. <sup>5</sup>Extended dominated: Extended dominated strategy is a strategy which is less effective and had a higher ICER than another strategy.

were COL10, COL5 and COL3, but these strategies showed greater financial burden on the NHI than the strategy of no screening did (Table 3).

When the reimbursement of colonoscopy was 60% higher than the current level, along with 50% coverage of screening cost by the NHI and the compliance rate of 55%, non-dominated strategies were COL at age 55, COL10, COL5 and COL3. Total medical costs of COL at age 55 and COL10 were less than that associated with no screening. In addition, the NHI's financial burden in case of COL at 55 was lower than that of no screening, and COL10 had relatively low incremental burden on the financial status of the NHI (Table 4).

Results of sensitivity analyses consistently showed the dominance of colonoscopy. In all cases, COL10, COL5 and COL3 were non-dominated strategies. When the reimbursement of colonoscopy was 60% higher than the current level, along with NHI's 50% coverage of screening cost and the compliance rate of 65%, COL10 had slightly higher total medical cost than no screening. In other cases, total medical cost of COL10 was lower than that of no screening, and NHI's financial burden associated with COL10 was lower or slightly higher than that of no screening. In all scenarios of various compliance rates, COL10, COL5 and COL3 were non-dominated strategies, and COL10 had lower or minimal incremental total medical cost and NHI's financial burden than the strategy of no screening.

## DISCUSSION

We compared 16 strategies for CRC screening, varying in the level of insurance coverage and reimbursement of colonoscopy by NHI to providers. In all scenarios, COL every 10 years, 5 years and 3 years were not ruled out by either simple or extended dominance, and COL every 10 years

was associated with lower total medical cost than the strategy of no screening.

Public awareness of the importance of CRC screening is increasing although the rate of screening remains low<sup>18</sup>. Previous studies have shown that the cost was a barrier to cancer screening<sup>14,26</sup>. Removing the financial barrier by providing insurance coverage is one of the effective methods to raise the screening compliance, but the financial burden on the NHI can be increasing as well. In other countries, screening for CRC usually leads to greater life expectancy but is more costly than no screening. Interestingly, in our study of Korea, COL every 10 years has lower total medical cost than the case of no screening. This difference might be due to the difference in cost structure. In the US, published cost estimates for the medical care of patients with CRC range from \$25 000 to \$45 000 and the cost of COL is approximately \$1 000<sup>14</sup>. In Korea, the cost estimate of CRC treatment in the first year ranges from \$5 000 to \$10 000 and the cost of COL was approximately \$50<sup>23,24</sup>. The ratio of treatment cost to COL cost ranges from 25:1 to 45:1 in the US and 100:1 to 200:1 in Korea. Since the cost of COL is relatively low in Korea, the screening is more cost-effective than in the US.

In Korea, the government started the national cancer-screening program (NCSP) in 1999, which included CRC screening in 2004. The government covers 50% of the screening cost for the insured and 100% for the low-income people. The primary method for CRC screening in NCSP is FOBT. Our study shows that the strategy of 'FOBT annually' costs more and carries heavier burden on NHI than the strategy of no screening, while COL every 10 years is less costly than no screening. These results suggest that COL every 10 years can be recommended as a primary screening strategy for CRC in NCSP. However, if COL is to be promoted as a screening tool, there must be sufficient manpower to deliver colonoscopy to the public. Unfortunately,

there are only a few medical endoscopists available to undertake COL in Korea. Korean physicians insist that they are not willing to contribute to increase in CRC screening rate because of low reimbursement of COL<sup>[25]</sup>. Some surveys indicate that strong recommendation from the physician is highly correlated with patient participation in CRC screening<sup>[27]</sup>. Therefore, raising reimbursement rate for CRC screening to physicians can be effective in changing their behavior, which will eventually improve compliance rate. Our model shows that when the reimbursement for COL increases up to 85 000 (Korean) won, which is 60% higher than the current level, along with NHI's 50% coverage of screening cost, COL every 10 years or 5 years not only has lower total medical cost and lower financial burden on the NHI, but also improves lifetime expectancy than FOBT annually (Table 4). In addition, the total medical cost of COL every 10 years was lower than that of no screening in Korea. More investment in CRC screening is ideal because it reduces the cost of conventional treatment and extends life expectancy. Health policy makers should understand the need to train medical, and possibly even non-medical, personnel to perform endoscopy and to find an effective policy to lead physicians to perform colonoscopy<sup>[26]</sup>.

Our analysis has several limitations. In the design of the model, we tried to reduce the complex natural history of CRC to a few essential states and to avoid assumptions on treatments for which little or no published data existed. For instance, we assumed that all cancers arose from polyps. And we used data from western countries if there were no published data available in Asia. There were possible differences between the races. Finally, we calculated only the direct costs and did not take into account the impact of CRC and screening on indirect costs.

In our conclusion, economic strategies for promoting screening compliance can be accompanied by expanding insurance coverage by the NHI and by increasing reimbursement for CRC screening to providers. And COL every 10 years is a cost-effective and cost saving screening strategy for CRC in Korea.

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