Impact of Whole-Body CT Screening on the Cost-effectiveness of CT Colonography[1]

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Purpose: To analyze the impact of adding computed tomographic (CT) imaging of the chest on the clinical effectiveness and cost-effectiveness of CT colonography to determine whether performing CT colonography and whole-body CT is a more clinically and cost-effective strategy than CT colonography alone when screening average-risk subjects.

Materials and Methods: A Markov model simulated the occurrence of colorectal neoplasia, extracolonic abominal-pelvic malignancy, lung cancer, coronary artery disease (CAD), and abdominal aortic aneurysm (AAA) in a cohort of 100 000 U.S. subjects aged 50 to 100 years. Cost-effectiveness of CT colonography and whole-body CT was compared with that of CT colonography alone; each test was assumed to be repeated every 10 years between ages of 50 and 80 years.

Results: Performing CT colonography and whole-body CT was more effective and costly than was CT colonography alone. The addition of chest CT was associated with a 22% increase in efficacy (life-years gained: 14 662 vs 11 990) and with a 48% increase in cost per person ($13 605 vs $9 223). Both strategies were cost effective as compared with no screening, with an incremental cost-effectiveness ratio (ICER) of $17 672 (CT colonography alone) and $44 337 (CT colonography and whole-body CT), respectively, but performing CT colonography and whole-body CT was not a cost-effective option when compared with CT colonography alone (ICER, $164 020). This was mainly a result of the high cost of false-positive follow-up for CAD and to the poor efficacy of lung cancer screening. Expected value of perfect information was $520 per patient.

Conclusion: The addition of chest CT to CT colonography does not appear to be a cost-effective alternative. Further research is needed before whole-body CT can be recommended in clinical practice.

Supplemental material: *http://radiology.rsnajnls.org/cgi/content/full/251/1/156/DC1*

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Awareness that prevention and early diagnosis may prevent the high mortality related to oncologic and cardiovascular diseases, together with the development of low-cost and accurate diagnostic tools, has led to the possibility of population-based screening, such as that for colorectal cancer and abdominal aortic aneurysm (AAA) (1,2). This paradigm has generated the possibility that multidetector CT, which is widely available (3) and capable of rapidly imaging virtually every organ, would lead to effective whole-body CT screening (4–6). In a previous simulation, whole-body CT was not cost effective as a screening strategy, providing a minimal average gain of 6 days in life expectancy at an additional cost of $151 000 per life-year gained (5,6).

A further development of CT technology in recent years is accurate investigation of the colorectum by using CT colonography (7–10). Because of the inevitable detection of extracolonic findings, CT colonography may be considered as the abdominal-pelvic component of a whole-body CT examination. However, in differing from whole-body CT, when including extracolonic findings, CT colonography was shown to be cost effective as compared with both no screening and optical colonoscopy (11). On the other hand, it is largely unknown whether performing chest CT for a patient undergoing CT colonography screening would further improve—or alternatively decrease—the cost-effectiveness of CT-based screening. To assess coronary artery disease (CAD) and to screen asymptomatic people for early treatable lung cancers could, in theory, reduce the mortality related to cardiovascular attacks (the highest rated cause of death) and lung cancer (the highest-rated cancer-related cause of death) in the U.S. population (6,12,13).

The aim of our simulation was to analyze the impact of performing chest CT on the clinical effectiveness and cost-effectiveness of CT colonography when screening average-risk subjects.

Advances in Knowledge

- In a Markov model, the addition of whole-body CT to CT colonographic screening resulted in a 22% increase in life-years gained as compared with CT colonography alone as a result of cardiovascular prevention and early detection of lung cancer; most life-years gained solely with the CT colonography strategy were related to colorectal carcinoma prevention (81%).
- The cost of CT colonography and whole-body CT was 48% higher as compared with CT colonography alone, mainly because of the work up of false-positive results.
- When assessing the single components of CT colonography and whole-body CT screening, the CT colonographic component appeared to be cost-saving, while the lung component was much less cost-effective.
- Probabilistic analysis showed a considerable degree of uncertainty on the cost-effectiveness of CT colonography and whole-body CT.
- Value-of-information analysis demonstrated that most of this uncertainty was related to the cost-effectiveness of CT-screening in preventing coronary artery disease.

Materials and Methods

Two authors (P.J.P. and D.H.K.) are consultants for Viatronix (New York, NY) and Fleet (Lynchburg, Va); P.J.P. is a consultant for Medicsight (London, England) and Covidien (Mansfield, Mass). All authors who were not consultants had control of inclusion of data and information.

The Model

A mathematical Markov model was constructed and simulation was performed for a cohort of 100 000 U.S. citizens (46% men, 54% women) aged 50 to 100 years, with screening performed every 10 years between the ages of 50 and 80 years (14). Age- and sex-specific mortality rates and population data were derived from the National Vital Statistics Report for the United States (15,16). As shown in Figure 1, we simulated the natural history of both the adenoma-carcinoma sequence and the most serious diseases, which may be detected by performing unenhanced CT of the chest, abdomen, and pelvis, including ovarian cancer, pancreatic cancer, hepatocellular carcinoma, renal cell carcinoma, and bronchogenic carcinoma, as well as AAA and CAD (5). Baseline assumptions, ranges, and calibration and validation details are reported in Appendix E1 (*http://radiology.rsnajnls.org/cgi/content/full/251/1/156/DC1*).

We assumed that the presence of each disease was independent of the presence of the other diseases. The cohort was assumed to be at average risk for each disease; therefore, it is not representative of citizens at higher risk, such as those with a family history of colorectal cancer or smoking.

Implication for Patient Care

- Although performing chest CT and CT colonography increases the clinical efficacy of a CT-based screening, its unfavorable cost-effectiveness and the related uncertainty preclude its recommended use in clinical practice.

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Abbreviations:
AAA = abdominal aortic aneurysm
CAD = coronary artery disease
EVPI = expected value of perfect information
FP = false-positive
ICER = incremental cost-effectiveness ratio

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See Materials and Methods for pertinent disclosures.

Screening Interventions

The health interventions superimposed on the natural history model were CT colonography (including the possible detection of abdominal-pelvic extracolonic findings) and CT colonography and whole-body CT (ie, chest CT and CT colonography), both performed without the use of intravenous contrast material.

Screening efficacy was simulated differently for the various diseases (Fig 2). The efficacy of CT colonography was related to the polyp and colorectal cancer detection rates listed in Appendix E1 *(http://radiology.rsnajnls.org/cgi/content/full/251/1/156/DC1)*. In the CT colonographic strategy, detection of a lesion of 6 mm or larger was followed up by performing colonoscopy and polypectomy. Of note, the baseline assumptions for CT colonographic polyp sensitivity reflected more pessimistic averages from meta-analyses that incorporated older two-dimensional techniques (17,18) and not the higher performance generally seen with state-of-the art techniques, such as three-dimensional polyp detection and oral contrast agent tagging (7–9,19).

Extracolonic cancer detection with both strategies was assumed to result in a downstaging of the disease when compared with no screening (5,11–13). Specifically, we assumed that the cancer-specific distribution of stages, as well as related costs and mortality, for extracolonic cancers detected at CT colonographic screening (with or without whole-body CT) would downshift approximately 50% (ie, a 50% shift from distant to regional or from regional to local disease). The distribution of local, regional, and distant disease was assumed to be different for asymptomatic extracolonic cancers detected at screening versus incident cancers in the nonscreened group, which would be more likely to present with symptoms at a more advanced stage. To adjust for lead-time bias, we reduced the overall gain in life expectancy by 50% as a result of the simulated downstaging. Because the natural history of cancer progression is not well established for most extracolonic cancers in general, we did not assume any window of opportunity for detecting cancers that arise prior to the actual year of whole-body CT screening; our model was designed on the basis of incident (not prevalent) data. No detectable precursor lesion was assumed for any extracolonic cancer. The downstaging was simulated to last for 1 year after each CT examination (5,11–13). The sensitivity and specificity values for CT detection of extracolonic cancers were derived from the literature (Appendix E1 *[http://radiology.rsnajnls.org/cgi/content/full/251/1/156/DC1]*). After a false-positive (FP) result for any disease,

Figure 1

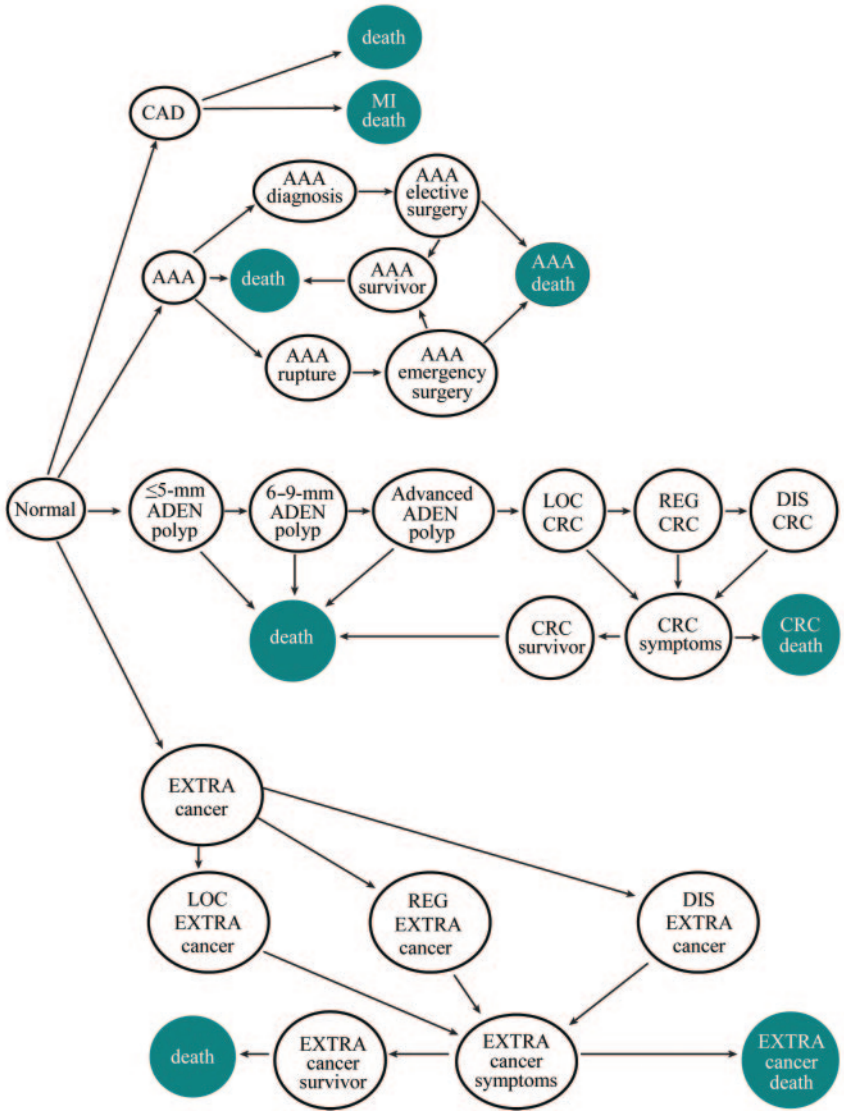

Figure 1: Model simulates progression from no lesions to death related to colorectal cancer (*CRC*), AAA, CAD, and extracolonic (*EXTRA*) cancers through various phases. Principal health states of natural disease history simulated in model are as follows: first group—no colorectal neoplasia; diminutive, small, or large adenomatous (*ADEN*) polyp; localized, regional, or distant colorectal cancer; colorectal cancer–related death; second group—no AAA, nonruptured AAA; ruptured AAA; elective (nonruptured) or emergency (ruptured)-related death; third group—no extracolonic cancer; localized, regional, or distant extracolonic malignancy (each considered separately); extracolonic cancer-related death; and fourth group—no CAD; CAD; CAD with myocardial infarction (*MI*)-related death. *DIS* = distant, *LOC* = localized, *REG* = regional.

a diagnostic follow-up was simulated, resulting in additional costs (5).

AAA detection resulted in a 5-year reduction of surgery performed for AAA rupture and in an increase in elective surgery performed for nonruptured AAA (20,21). CAD detection was assumed to result in the initiation of statin therapy in 20% of CAD patients diagnosed on the basis of calcium scoring and in a 30% mortality reduction in such a treated group (22).

We also included the additional theoretical risk of cancer mortality induced by each CT scan, distributing the lifetime risk of 0.08%, which has been estimated for a single whole-body CT performed at age 50 years (23). This risk was considered to be halved at age 70 years and further reduced to 0.03% at age 80 years (23).

Costs

Medicare reimbursement data for screening and surveillance procedures, colorectal cancer, and extracolonic malignancies according to stage of disease at diagnosis, elective or emergency surgery for AAA, and statin therapy were converted to 2007 U.S. dollars by using the medical component of the consumer price index for that year (24). Costs for extracolonic cancers differed between routine or screening diagnosis to reflect the simulated downstaging (5). The costs of additional imaging work-up for FP results at CT colonography, with or without whole-body CT, were adopted from the literature (5). Indirect costs for CT colonography with or without whole-body CT and optical colonoscopy were estimated on the basis of a median hourly income rate of $18.62/h (25,26).

Cost-effectiveness Analysis

The clinical effectiveness of screening is measured in terms of life-years gained through prevention or downstaging of all included diseases. In the natural history and screening models, the life-years lost by the age-dependent proportion of patients dying prematurely of colorectal cancer, extracolonic malignancies, AAA, or CAD are accumulated for each cycle during the entire expected lifetime. The number of life-years gained as a result of screening corresponds to the difference in life-years lost from cancer- or AAA- or CAD-related deaths with and without screening by using the Markov model, or between the different screening strategies. The incremental cost-effectiveness ratio (ICER) between two strategies was defined as the difference in cost divided by the difference in life expectancy, which represents the cost per life-year gained (Fig 2). Future costs and life-years gained were discounted by using an annual rate of 3%. An ICER of $100 000 per life-year gained was used as a threshold level to differentiate between efficient and inefficient procedures (27,28). Net monetary benefit was calculated by multiplying the number of life-years gained in each strategy with the adopted threshold level and subtracting the cost (29). The model was simulated by using electronic spreadsheets (Excel; Microsoft, Redmond, Wash).

Sensitivity Analysis and Value-of-Information Analysis

Model parameters were varied simultaneously and randomly for 10 000 iterations in a Monte Carlo simulation (Lumenaut, version 3.4.9; Lumenaut, Hong Kong, China), providing estimates on the variability in cost-effectiveness, expressed as percentiles of 2.5 and 97.5, which arises when variables are allowed to take on distributions. Second, a systematic sensitivity analysis on the cost-effectiveness of performing CT colonography and whole-body CT as compared with CT colonography alone was determined by using the ranges shown in Table E1 (*http://radiology.rsnajnls.org/cgi/content/full/251/1/156/DC1*).

The value-of-information analysis combines the likelihood of making the wrong decision with the foregone benefit of that wrong decision, which ad-

Figure 2

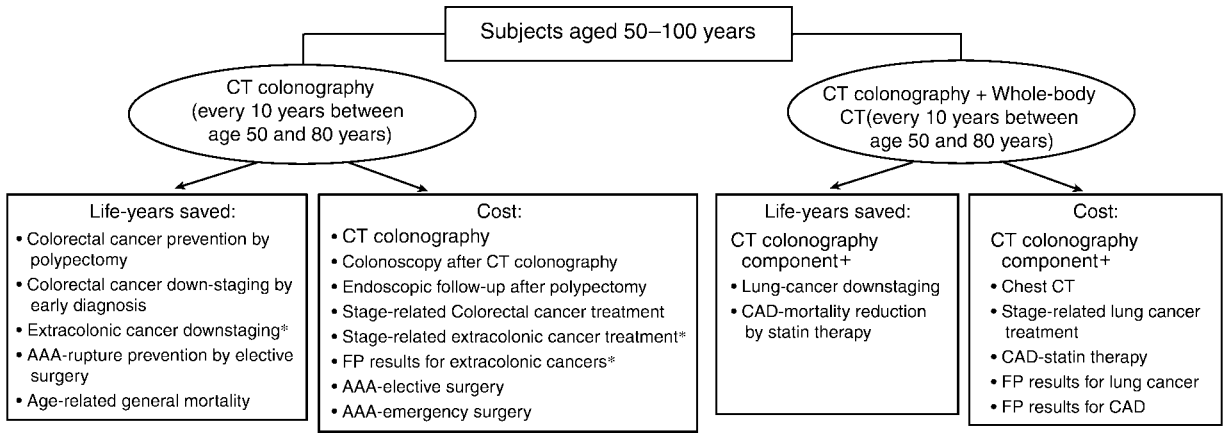

Figure 2: Schematic flowchart of decision model with efficacy and cost outcomes for each simulated screening strategy. Note that efficacy and costs of CT colonography are also included in CT colonography and whole-body CT program. Downstaging indicates that when cancer is detected at screening, its stage is shifted by approximately 50% in earlier stage as compared with no screening. * = Only for abdominal-pelvic cancer.

dresses whether more information is necessary. The expected value of perfect information (EVPI) estimates the value of obtaining information about all the unknown parameters—in other words, the value of removing all uncertainty related to the decision problem. Total EVPI per patient was estimated (29). Population EVPI was also computed by taking into account that each year in the United States, 64 million CT examinations are performed and that CT colonography accounts for 0.2% (n = 12 800) of those (30). Lifetime for this technology was assumed to be 10 years. Partial EVPI was assessed for individual parameters or sets of parameters to identify the main causes of uncertainty related to the decision between the study options. EVPI was discounted at a rate of 3% per year.

Table 1

Modeled Outcomes at Baseline Assumptions for Population Strategies

Variable	No Screening	CT Colonography Alone	CT Colonography and Whole-Body CT
No. of colorectal cancer cases prevented	0	3705	3705
Colorectal cancer prevention rate (%)	0	62.4	62.4
Life-years gained			
Colorectal cancer	0	9767	9767
AAA	0	2024	2024
CAD	0	0	2390
Lung cancer	0	0	282
Abdominal-pelvic extracolonic cancers	0	199	199
Total	0	11 990	14 662
Cost per person ($)			
Disease treatment	7104	6038	6639
Follow-up for FP results	0	907	4032
Screening test	0	2278	2934
Total cost per person	7104	9223	13 605
ICER*			
Versus no screening	. . .	17 672	44 337
Versus CT colonography	. . .	. . .	164 020
Net monetary benefit per person ($)†	. . .	2767	1057

* Measured as money per life-year gained.

† Calculated by using an assumed threshold level of $100 000 per life-year gained.

Results

CT Colonographic Strategy

CT colonographic screening resulted in an overall gain of 11 990 life-years (44 days per person screened) when compared with no screening but was significantly more expensive ($9223 vs $7104 per person, Table 1). CT colonographic efficacy was mainly related to the saving of 9767 (81.5%) life-years because of the prevention of 3705 (prevention rate, 62.4%) cases of colorectal cancer and, to a lesser extent, to the early detection of AAA (2024 life-years; prevention rate, 16.9%), while the impact of abdominal-pelvic extracolonic cancers was marginal (199 life-years; prevention rate, 1.6%). Regarding the costs of CT colonography screening, $6038 per person (65%) were spent for the procedure itself, $2278 per person (25%) for the treatment of the six considered diseases mentioned above, and the remaining $907 (10%) for the work up of FP results. CT colonography appeared to be a cost-effective strategy as compared with no screening (ICER, $17 672).

CT Colonography and Whole-Body CT

The addition of chest CT imaging to CT colonography resulted in the further gain of 2672 life-years because of the prevention of myocardial infarction (2390 life-years) and the early detection of lung cancer (282 life-years), leading to an overall gain of 14 662 life-years, as compared with no screening. This corresponds to a 22% increase in efficacy as compared with CT colonography. However, the higher efficacy was set off by a 48% increase in the program cost, leading to an overall expenditure of $13 605 per person. Although performing CT colonography and whole-body CT was still cost-effective as compared with no screening (ICER, $44 337), it was not a cost-effective alternative to CT colonography alone (ICER, $164 020).

To further clarify the reasons for the cost-ineffectiveness of performing CT colonography and whole-body CT, we separately assessed the incremental cost (as compared with no screening) and the efficacy of the four main components of this strategy. As shown in Table 2, when not considering the extracolonic findings included in the abdominal-pelvic part of CT colonography, the CT colonographic component was characterized by the highest number of life-years saved (n = 9767) and by a dramatic reduction of costs related to colorectal cancer treatment as a result of prevention. When considering only the cost associated with the three-dimensional reconstruction of the colon ($160)—and excluding the cost related to the abdominal-pelvic CT scan—and the cost of colonoscopy after CT colonography, the CT colonographic component resulted in a net savings (as compared with no screening) equal to $94 per person. On the other hand, the analysis of the abdominal-pelvic component of a CT scan revealed how the moderate efficacy of AAA prevention (2024 life-years) was offset by the heavy expenditure owing to the work up of FP results for extracolonic cancers, so that the ICER of this component ($99 568) was practically equal to the adopted threshold level.

The cost-effectiveness of the two chest components of the strategy that used CT colonography and whole-body CT showed a different behavior. The

CAD component was characterized by the highest cost for work up of FP results—owing to an assumed specificity of 51%—that neutralized the moderate efficacy owing to cardiovascular prevention, so that such a component appeared to be cost-ineffective (ICER, $154 095). However, the lung component showed the smallest expenditure for the work up of FP results, also coupled with a net savings for disease treatment cost, but this was offset by the lowest efficacy among the different components (282 life-years saved), so that the lung component was the most cost-ineffective when compared with no screening (ICER, $480 543). Radiation-induced cancer mortality accounted for 78 deaths.

Sensitivity Analysis

Sensitivity analysis was mainly restricted to those variables capable of modifying the relative cost-effectiveness of the two strategies compared in this analysis (CT colonography alone vs CT colonography and whole-body CT). Since changes in the assumptions of the abdominal-pelvic and CT colonographic components equally affected the two strategies without altering the relative ICER, sensitivity analysis addressed only the efficacy and the costs of the two chest components (Table 3).

CAD.—CAD efficacy was a result of the baseline 30% mortality reduction achieved by using statin therapy in 20% of patients with CAD detected by using CT colonography and whole-body CT. An increase of the statin-related mortality reduction to 55% reduced the ICER of CT colonography and whole-body CT (as compared with CT colonography alone) to less than $100 000 (Table 3). The ICER of CT colonography and whole-body CT also was related to CAD prevalence. Two- and threefold increases of CAD prevalence reduced the ICER to $99 082 and $75 509, respectively.

The cost of the program was mainly related to the work up of FP results and the specificity of CAD diagnosis. A reduction of the cost of FP result work up from $2222 to $600 or an increase in specificity from 51% to 86% allowed CT colonography and whole-body CT to be a cost-effective alternative to CT colonography alone (Table 3).

Lung cancer screening.—At univariate analysis, optimistic assumptions about CT accuracy for lung cancer, cost of FP result follow-up, or lead-time bias did not affect the cost-ineffectiveness of CT colonography and whole-body CT (Table 3). Only a sevenfold increase of lung cancer prevalence—corresponding to a 1.6% risk for a 60-year-old subject—reduced the ICER of CT colonography and whole-body CT to $99 816. At two-way sensitivity analysis, assuming no lead-time bias, a threefold increase in lung cancer prevalence reduced the ICER to less than $100 000.

The cost of chest CT equally affected both components (CAD and lung cancer screening). However, even when assuming no additional cost for chest CT, CT colonography and whole-body CT was not cost-effective, mainly because of the high cost of FP result work up.

Because of a lower incidence of lung cancer and CAD in women as compared with men, the ICER of CT colonography and whole-body CT as compared with CT colonography alone was slightly higher in women ($190 410) than in men ($133 041).

Value-of-Information Analysis

At probabilistic Monte Carlo analysis of the ICER between CT colonography and whole-body CT and CT colonography alone, the 2.5 and 97.5 percentiles of the 10 000 iterations were $63 155 and $251 064, respectively. The ICER was less than $100 000 in 32% of the iterations and higher in the remaining 68%.

The uncertainty between CT colonography and whole-body CT and CT colonography alone resulted in an EVPI of $520 per patient and an EVPI of $56 777 030 in a discounted population. This uncertainty was exclusively related to the parameters involved in the CAD component, since the partial EVPI for those related to the lung cancer screening component was equal to $0. When analyzing the uncertainty related to the CAD component, the partial EVPI was higher for parameters associated with the cost of FP result work up (specificity and work-up cost) than for those associated with CAD efficacy, being equal to $184 and $29, respectively. Individual EVPIs are shown in Table 4.

Discussion

Our simulation shows that the addition of chest CT to CT colonography is not a cost-effective strategy when screening

Table 2

Efficacy and Costs for Different Screening Components

CT Colonography and Whole-Body CT Screening	Life-Years Saved vs No Screening	Incremental Cost per Person for Disease Treatment vs No Screening ($)	Cost per Person for FP Result ($)	Cost per Person for Screening ($)	Total Incremental Cost per Person vs No Screening ($)	ICER vs No Screening ($)
Abdominal-pelvic imaging	2223	182	907	1123	2213	99 568
CT colonography alone	9767	−1248	. . .	1154	−94	94*
CAD	2390	604	2422	656	3683	154 095
Lung CT	282	−3	702	656	1355	480 543

Note.—Efficacy (life-years saved) and costs have been separately reported for each of the four different components in which CT colonography and whole-body CT may be theoretically divided. Incremental cost per person and cost-effectiveness are also reported.

* Measured as savings per person.

Table 3

Sensitivity Analysis of ICER

Variable	ICER for CT Colonography and Whole-Body CT vs CT Colonography Alone ($)
Baseline	164 020
CAD parameters	
Statin-related mortality reduction of 5%	644 280
Statin-related mortality reduction of 55%	93 972
CAD prevalence decrease by 50%	272 627
CAD prevalence increase (%)	
50	121 650
100	99 082
200	75 509
Cost of work-up of FP results ($)	
500	93 755
1000	114 157
2500	175 364
3500	216 168
Specificity (%)	
25	212 129
75	119 611
85	101 108
95	82 605
Lung cancer screening parameters	
CT sensitivity (%)	
65	167 330
95	160 838
CT specificity (%)	
65	191 855
95	145 463
Cost of work-up of FP results ($)	
500	144 809
1000	151 888
3000	180 201
4000	194 357
Lead-time bias (%)	
0	132 495
25	146 852
75	173 154
Duration of downstaging, 2 y	118 796
Lung cancer incidence increase	
Threefold	138 938
Fivefold	120 463
Sevenfold	99 816
Ninefold	90 296
Lung cancer incidence decreased by 50%	171 758
Chest CT cost ($)	
150	151 529
75	145 283
0	139 454
Men	133 041
Women	190 410

Table 4

Partial EVPI per Patient for Individual Variables

Variable	EVPI per Patient ($)
Specificity for CAD	94
Statin-related CAD mortality reduction	16
Cost of work-up for CAD FP results	9
Statin therapy cost	0

average-risk subjects. This mainly depends on the poor efficacy of lung cancer screening in a low-risk population and the rather high cost related to the work up of FP results with CAD.

When analyzing the lung cancer component, the high ICER of over $400 000 per life-year gained is similar to the $558 600 per quality-adjusted life-year gained by using a previous model in low-risk subjects (13). We also showed that when simulating a very high risk of lung cancer, as with active smokers, the cost-effectiveness of CT colonography and whole-body CT substantially improves. However, when simulating CT colonography and whole-body CT in a population with a sevenfold increase in lung cancer risk—similar to the incidence rate assessed for heavy smokers (31,32)—the ICER of CT colonography and whole-body CT was still close to the accepted $100 000 threshold level, raising doubts about its cost-effectiveness in clinical practice.

Prevention of CAD by using the CAD component was moderately effective because of the mortality reduction simulated to be achieved with statin therapy. Although not cost-effective in the reference scenario, the CAD component was sensitive to change in disease prevalence and cost. However, only a threefold increase in disease prevalence or a 73% cost reduction were associated with an ICER below $100 000, suggesting a potential cost-effectiveness for CT colonography and whole-body CT only in selected scenarios. Partial expected value of information analysis indicated that future research should mainly focus on the rate and work-up cost of subjects with FP results for CAD.

Our study entails a separate analysis for the two components of a CT colonographic screening. When considering only the cost associated with the three-dimensional reconstruction of the colon, the CT colonographic component was cost saving, similar to a previous simulation for flexible sigmoidoscopy (33). This was a result of the large number of life-years gained with colorectal cancer prevention when compared with the downstaging of extracolonic cancers. This is largely related to two factors: First, colorectal cancer is a major cause of cancer-related mortality (1); and second, colorectal cancer prevention is much more effective in terms of mortality reduction than the simple downstaging assumed for other cancers. According to our simulation, patients undergoing CT screening without CT colonography are gaining much more benefit from cardiovascular prevention than from the often-desired cancer prevention. Only the CT colonographic component can alter the balance in favor of prevention of cancer-related death.

Our model had limitations. Poor knowledge of the natural history of extracolonic malignancies prevented us from simulating the prevalence of these diseases, so that our estimate of their incidence may be overly conservative, decreasing the cost-effectiveness of CT colonography and whole-body CT screening. Given the lack of clinical evidence, it is uncertain whether early detection of asymptomatic extracolonic cancers may effectively improve 5-year survival. Different assumptions regarding colorectal cancer pathogenesis, such as those on the de novo route, could increase the ICER as compared with no screening, without affecting the ICER between CT colonography and whole-body CT and CT colonography alone (34–36).

In conclusion, our simulation shows that performing chest CT and CT colonography is not a cost-effective alternative to CT colonography alone, and further research is needed before it can be recommended in clinical practice.

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