Economic Evaluation of Population-based Screening for Colorectal Cancer

Before CCOHTA decides to undertake a health technology assessment, a pre-assessment of the literature is performed. Pre-assessments are based on a limited literature search; they are not extensive, systematic reviews of the literature. They are provided here as a quick guide to important, current assessment information on this topic. Readers are cautioned that the pre-assessments have not been externally peer reviewed.

**Introduction**

In Canada, colorectal cancer (CRC) is the third most commonly diagnosed cancer and the second most common cause of cancer-related mortality. An estimated 17,200 new CRC cases and 6,400 deaths from CRC occurred in Canada in 2001. The prognosis and survival of those with CRC is related to the stage of the cancer at the time of diagnosis. CRC is treatable and often curable if the cancer is localized. As a result, the possibility of screening for this disease is compelling.

Early detection of CRC through screening (secondary prevention) is a strategy for reducing the mortality and morbidity associated with this disease. The Canadian Task Force on Preventive Health Care has addressed screening for colorectal cancer at the individual (clinical) level. The Task Force concluded that there is strong evidence for using the fecal occult blood test (FOBT) in clinical practice to screen those individuals at high risk for CRC.

However, the Task Force did not specifically deal with population-based screening of those at average-risk for CRC. Such a strategy presupposes that a substantial proportion of the population needs to be screened in order to achieve the desired reductions in mortality. The size and nature of population-based screening (e.g. the targeting of average risk individuals) requires a closer examination of the appropriateness of the screened population, the potential harms (e.g. false positives), and the program’s cost-effectiveness, than does screening at the individual level. In Canada, provinces have established population-based screening programs for breast cancer and, to a lesser extent, for cervical cancer.

To date, no country has implemented a population-based CRC screening program at the national level, although pilot studies and large-scale population screening programs have taken place in several countries. In Canada, no province has implemented such a program, although several provinces are considering their potential impact. After reviewing the evidence, Cancer Care Ontario (1999) recommended that a CRC screening program using FOBT be introduced for average risk individuals who are age 50 and older.

The National Committee on Colorectal Cancer Screening (NCCCS) was established in 1998 to “examine the implementation of population-based colorectal cancer screening in Canada... and develop recommendations”. It includes nominees from the provincial cancer agencies/foundations, the Canadian Cancer Society/National Cancer Institute of Canada, professional and non-professional organizations and Health Canada. The Committee developed nine criteria (based on the WHO screening principles) for assessing such a program. In order to justify expenditure for the program, the Committee recognized that “the resources allocated to the screening program (including testing, diagnosis and treatment of patients diagnosed) should be economically balanced in relation to other health care priorities.”
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Research Questions

The preliminary research questions posed by CCOHTA regarding population-based CRC screening for average-risk individuals are:

1. Which screening tests are available and what are their performance characteristics (e.g. sensitivity, specificity, positive predictive value)?
2. What is the evidence of efficacy/effectiveness of specific screening tests?
3. Is there evidence that a CRC screening program (including screening, diagnosis and treatment of those with CRC) would reduce CRC mortality?
4. What are the risks associated with this program?
5. What would the resource implications of such a program in Canada be?
6. Would such a program be a cost-effective strategy?
7. In which sub-populations is CRC screening most effective and cost-effective?
8. What screening interval (frequency) is most effective and cost-effective?
9. Is a population-based CRC screening program appropriate for Canada?

Assessment Process

A draft report by the NCCCS was used as the basis for this pre-assessment. This report (made available to CCOHTA on Nov 29, 2001) presented the evidence surrounding population-based CRC screening and assessed the effectiveness, cost-effectiveness and impact on resources of such a program in a Canadian context. Additional literature was identified through checking HTA websites and scanning recent issues of journals.

Summary of Findings

National Committee on Colorectal Cancer Screening (NCCCS) Report

The NCCCS report considered four options for CRC screening tests: fecal occult blood test (FOBT), colonoscopy, sigmoidoscopy and barium enema. The analysis was based on using FOBT since it was shown to significantly reduce CRC mortality (by 15-21%) in RCTs conducted in Denmark, the UK and the U.S. In particular, data from the Denmark biennial screening study was used to model FOBT parameters. The three main types of FOBT used for CRC screening (guaiac tests, immunological assays and heme-porphyrin assays) are available in Canada. FOBT sensitivity and specificity in the Danish study was 51% and 98%, respectively. Evidence supporting the other three tests was considered insufficient for assessing population-based CRC screening. Other model parameter values were based on Canadian data where possible.
Statistics Canada’s Population Health Model (POHEM) was used to assess the impact of CRC screening on mortality, resource use, costs and cost-effectiveness. POHEM is a model that simulates a sample of individuals through their life paths based on inputs regarding CRC disease events and CRC screening parameters, including treatment options and costs. The costs and consequences of a biennial screening program were compared with those of no CRC screening program.

The Core (Base) screening scenario assumes:
- participants are ages 50–74
- biennial FOBT screening by a family physician
- 67% program participation rate; 93% re-screen rate (number of annual FOBT screens in Canada = 2.5 million)
- no follow-up for a negative FOBT result
- follow-up diagnostic colonoscopy for a positive FOBT result; further follow-up dependent on the colonoscopy result (CRC or polyp detected, no CRC)
- FOBT false positives of 2% and a low risk of serious complications (perforation, bleeding, death) due to the follow-up colonoscopy

Program resource use included:
- fixed program overhead
- physician visits
- FOBT kit
- follow-up consultation
- diagnostic investigation using colonoscopy
- polypectomy.

The cost to run the biennial screening program averaged $40 per screened participant, but this would vary with the program structure, target population numbers and the compliance rate. Other model parameters relate to: the number of physician visits per FOBT; the sensitivity and specificity of colonoscopy; and the CRC stage distribution of the screened population. Impacts on participants, such as anxiety due to a false positive FOBT result and the quality of life-years gained, as well as indirect costs through productivity losses, were not included in the analysis. Overall, the methodology used in the NCCCS report appears to be of high quality.

Some of the key model results for the Core scenario and several alternative scenarios are shown in Tables 1 and 2 below. The analysis also indicated that the optimal age to start screening is 50 years and to stop screening is 75 years, based on gains in life expectancy and the cost per life-year gained.
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The Canadian Coordinating Office for Health Technology Assessment (CCOHTA)

Table 1

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<th>Core scenario</th>
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<tr>
<td><strong>Clinical results:</strong></td>
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<tr>
<td>Reduced CRC mortality after 10 years</td>
<td>16.7% (95% CI, 15.8% - 17.6%)</td>
</tr>
<tr>
<td>no. FOBT &amp; no. colonoscopies to detect 1 CRC case</td>
<td>841; 17</td>
</tr>
<tr>
<td>no. FOBT &amp; no. colonoscopies to avoid 1 CRC death</td>
<td>1,278; 27</td>
</tr>
<tr>
<td>no. CRC deaths avoided for each death due to colonoscopy complications</td>
<td>178</td>
</tr>
<tr>
<td>Life expectancy gain for each CRC case detected</td>
<td>1.75 years</td>
</tr>
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**Costs:**
- Cost per year of biennial program in Canada (5% discounting): $112 million
- Screening costs as % of total program costs: 24%
- Projected increase in colonoscopies due to program: 15%
- Cost per year of annual program in Canada (5% discounting): $194 million

Table 2

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<th>Core scenario</th>
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<tr>
<td>Cost per Life-Year Gained (5% discounting)</td>
<td>$12,000</td>
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**Alternative scenarios:**
- (a) Annual screening: $13,500
- (b) High cost scenario: $18,500
- (c) Participation rate of 50%: $15,700
- (d) Follow-up using 50% barium enema & 50% colonoscopy: $11,700

The report concluded that:
1. Based on a cost-effectiveness threshold of $40,000 per life-year gained, the analysis showed that annual and biennial population-based screening using FOBT are cost-effective in Canada.
2. Annual screening is cost-effective but requires 75% more resources than that for biennial screening.

The Canadian Coordinating Office for Health Technology Assessment (CCOHTA) is a non-profit organization funded by the federal, provincial and territorial governments. (www.ccohta.ca)
3. Major drivers of reduced CRC mortality are: (a) the participation rate for the first screen and (b) the frequency of screening. The likely rates of participation that can be achieved in Canada are unknown; any projection in rates should be assessed carefully in order to accurately evaluate the effectiveness of population-based screening.

The NCCCS concluded that the potential benefits of population-based biennial screening of CRC using FOBT outweighs the potential harms, and they recommended that such a program be implemented. One member dissented from this view, citing the possibility of serious harm from the program.

The NCCCS report identified three other economic evaluations on CRC screening, all of which supported CRC screening:

1. Frazier (2000) reported that CRC screening of average-risk individuals was as cost-effective as screening for other cancers. Rates of compliance significantly affect the cost-effectiveness results.

2. Winawer (1997) reported that the cost-effectiveness of CRC screening in the U.S. (US $20,000 per life-year gained) compared favourably with other screening programs. Annual FOBT screening for those ages 50-74 was said to be more cost-effective than biennial mammography for women ages 50-59.

3. Gyrd-Hasen (1998) reported that CRC screening was more cost-effective than screening for cervical cancer in Denmark.

Other Economic Evaluations

Three other economic evaluations of CRC screening were retrieved separately:

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2. Sonnenberg (Arch Intern Med 2002;162(2):163-8) assessed colonoscopy as a CRC screening strategy. The analysis showed that a repeat colonoscopy every 10 years for average-risk individuals starting from age 50 was cost-effective (US $11,000 per life-year gained) compared with no screening. A single colonoscopy at age 65 would also be cost-effective (US $3,000 per life-year gained), if high costs or low participant compliance precluded a repeat colonoscopy.

3. Interestingly, an earlier assessment by Sonnenberg (Ann Intern Med 2000; 133(8):573-84) showed that a colonoscopy once every 10 years was more cost-effective than a screening sigmoidoscopy every five years or a FOBT annually. Although colonoscopy was the more expensive option for initial screening, it prevented more CRC and saved more life-years. (The NCCCS report cites the lack of compliance as a possible problem for using colonoscopy as an initial screening test in a population-based program. The lack of sufficient evidence of efficacy supporting the use of colonoscopy as the initial screening test was also cited as a reason for not evaluating this as a screening option. The Cancer Care Ontario expert panel proposes that periodic screening with sigmoidoscopy in combination with FOBT or colonoscopy be studied further.)

Conclusion

The National Committee on Colorectal Cancer Screening has recently assessed colorectal cancer screening in a Canadian setting. The Committee produced a high-quality report that appears to satisfactorily address all preliminary research questions. Further work by CCOHTA would be redundant.