Measuring performance and quality indicators of CRC screening

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Performance indicators of screening programmes
Cancer screening is efficacious

„Evidence exists concerning the efficacy of screening for breast cancer and colorectal cancer, derived from randomised trials, and for cervical cancer, derived from observational studies.“ (Council Recommendation)

Colorectal cancer screening with FOBT

Mandel et al (1993) – United States
- decrease in mortality by 33 %

- decrease in incidence by 20 %

Hardcastle et al (1996) – United Kingdom
- decrease in mortality by 15 %

- decrease in mortality by 11 %,
  by 43% in persons participating in all 9 rounds

Colorectal cancer screening with colonoscopy

Winawer et al (1993) – United States
- decrease in incidence by 76-90 %

Kahi et al (2009) – United States
- decrease in incidence by 67 %, decrease in mortality by 65 %

Brenner et al (2010) – Germany
- decrease in advanced neoplasia rate by 48 %
Efficacy of a screening effort in studies does not guarantee effectiveness in different settings.

Figure 7.41 Age standardised incidence rate – comparison of time trends between Finland and the Czech Republic (source of data: Cancer Incidence in Five Continents (Parkin, Whelan, Ferlay, & Storm, 2005), CNCR).
Organised cancer screening programmes

- Screening for cancer of breast, colorectum and uterine cervix is effective in decreasing mortality of the disease.
- These programmes are recommended to all member states by the Council of the European Union (2003/878/EC).
- To guarantee their effectiveness, safety and cost-effectiveness, it is highly recommended to implement the prevention as organized programmes comprising:
  - an explicit policy, with specified age categories, method and interval of screening
  - defined target population
  - a management team responsible for the implementation
  - a health care team for decisions and care
  - a quality assurance structure (performance monitoring including collection of all relevant data)
  - a method for identifying cancer occurrence in the target population

IARC Handbooks of Cancer Prevention
Sources of data for colorectal cancer screening information support

Monitoring of Cancer Burden
- epidemiology of cancer in target population
- evaluation of screening programmes impact
Source of data: CZECH NATIONAL CANCER REGISTRY
13 regional data collection points / 57 district points
annual no. of records: 8,236 colorectal cancer cases in 2008

Performance Monitoring of Health Care Facilities
- performance indicators at screening centres
- detection of cancer and precancerous lesions
Source of data: RECOMMENDED HEALTH CARE FACILITIES
160 centres (summer 2011)
annual no. of records: 22,227 preventive colonoscopies in 2010

Monitoring using Administrative Data
- population-based performance indicators
- monitoring of programmes accessibility by target population
- assessment of programmes cost-effectiveness
Source of data: HEALTH INSURANCE COMPANIES – NATIONAL REFERENCE CENTRE
8 health insurance companies / 4,400 general practitioner offices, 1,200 gynaecologist offices
annual no. of records: 521,000 FOBTs performed in 2010

Information Support Provider
MASARYK UNIVERSITY, INSTITUTE OF BIOSTATISTICS AND ANALYSES
Performance indicators in screening programmes

- **EARLY PERFORMANCE INDICATORS**
  - relating to target population
    - coverage by examination, ...
  - relating to screening centres
    - detection rates, complication rates, ...

- **LONG-TERM IMPACT INDICATORS**
  - relating to screening outcomes
    - mortality, incidence rates

  *definite indicator of success*

- decrease in mortality is inevitably long-term and difficult to measure

**MONITORING OF SCREENING PROGRAMMES REQUIRE EARLY PERFORMANCE INDICATORS**

- Payers – National Reference Centre
- Screening Registry
- Czech National Cancer Registry
Czech Cancer Screening Registries

- recommended by EU Council to „collect, manage and evaluate data on all screening tests, assessment and final diagnoses“

- screening programmes are equipped with specific registries
  - Breast Cancer Screening Registry
  - Colorectal Cancer Screening Registry
  - Cervical Cancer Screening Registry

- datasets include information on final diagnoses (including precancerous lesions)

  IRREPLACEABLE SOURCE OF DATA

- registries enable computation of basic performance indicators, as internationally recommended
Colorectal Cancer Screening Registry

- web-based application and database for collection, validation and reporting of data related to preventive colonoscopies
Performance indicators of screening programmes according to European Guidelines
Early performance indicators

Programme coverage and uptake

- Coverage by invitation
  Recommendation: 95%

- Coverage by examination

- Uptake (participation) rate
  Recommendation: 45% / 65%

Source: European Guidelines
Outcomes with FOBT for primary screening

- Inadequate FOBT rate: data not collected
- Positive FOBT rate
- Referral to follow-up colonoscopy after FOBT
- Follow-up colonoscopy compliance rate: no individual linkage between FOBT and colonoscopy
- Completion of follow-up colonoscopy after FOBT
  Recommendation: 90% / 95%
- Detection rates of FOBT screening programme: no individual linkage between FOBT and colonoscopy
- Stage of screen-detected cancers
  Recommendation: favourable compared to clinically diagnosed
- Positive predictive values for FOBT screening programmes
- Endoscopic complications in FOBT screening programme
  Recommendation: monitor the rate carefully

Source: European Guidelines
Early performance indicators

- Outcomes with colonoscopy (CS) as primary screening test
  - Inadequate CS rates: data not collected
  - Complete CS rate
  - Positive CS rate
  - Detection rates of CS screening programmes
  - Referral to follow-up colonoscopy after CS: data not collected
  - Follow-up colonoscopy compliance rate after screening CS
  - Completion of follow-up colonoscopy after CS
  - Endoscopic complications of CS screening programmes
  - Recommendation: monitor the rate carefully

Source: European Guidelines
Screening organisation

- Time interval between completion of test and receipt of results
- Time interval between positive test and follow-up colonoscopy
  Recommendation: 90% / 95% within 31 days
- Time interval between positive endoscopy and start of definitive management
- Time interval between consecutive primary screening tests
  not yet available through NRC

Source: European Guidelines
Long-term impact indicators

- Interval cancers
  - no individual linkage between test and cancer
- CRC incidence rates
- Rates of advanced-stage disease
- CRC mortality rates
  - Population trends
  - Cohort studies  
  - Case-control studies  
  - no individual linkage between test and cancer

Source: European Guidelines
separate sources of data are available for performance monitoring
  - administrative data – FOBTs
  - screening registry data – screening and follow-up colonoscopies
  - cancer registry data – colorectal cancer cases

it is not yet possible to perform individual linkage, precluding
  - estimation of detection rates of FOBT screening
  - estimation of interval cancer rates (programme sensitivity)
  - estimation of programme effectiveness based on individual records
Profiling providers of colorectal cancer screening
to identify providers of preventive colonoscopy examinations, whose performance shows deviation from recommended benchmark

- problems
  - small caseloads
  - case-mix adjustments
  - regression-to-the mean bias

- proposed solution
  - hierarchical Bayesian model
  - computation of the probability that a provider has performed acceptably

Improving the statistical approach to health care provider profiling - Christiansen et al, 1997
**Profiling of colonoscopy providers**

**Methods**

- **presented example**
  - estimated proportion of patients at follow-up colonoscopy detected with adenoma (PPV of FOBT for adenoma) in 2010
  - adjustment for age and sex
  - logistic regression, fitted with WinBugs

\[
\text{logit} \pi(X_{ij}, b_i) = \beta_0 + x_{ij,1} \beta_1 + \ldots + x_{ij,p} \beta_p + b_i
\]

\[
b_i \sim N(0, \sigma)
\]

\(X_{ij} = (x_{ij,1}, \ldots, x_{ij,p})\) contains \(p\) patient-specific predictors values in \(j^{th}\) patient at \(i^{th}\) centre \((j = 1, \ldots, n_i)\)

\(b_i\) shows centre-specific effect (random effect)

\(\pi(X_{ij}, b_i)\) is a probability of detecting adenoma in \(j^{th}\) patient at \(i^{th}\) centre
Profiling of colonoscopy providers: Proportion of patients at follow-up colonoscopy detected with adenoma

**Estimated indicator** → **Probability distribution** → **Probability achieving benchmark**

0% 20% 40% 60% 80% 100%

**Challenges**
- easy-to-use reporting
- assuring adequacy of used models
- setting acceptable benchmarks

143 centres (> 50 CS in 2010)
22 centres with possibly inadequate adenoma detection

< 5% prob.
Overcoming barriers in availability of data
availability of independent sources of data precludes direct estimation of colorectal cancer screening outcomes (completeness of registry is < 100%)

modelling using parameters estimated from different sources of data can help us to determine outcomes of the FOBT screening programme
Estimating outcomes of CRC screening

Methods

- Screening programme
  - FOBT
- Participation
  - FOBT+
  - FOBT-
  - Refusal of follow-up
- Colonoscopy
  - Advanced adenoma
  - Polypectomy
- Markov model of disease natural history in absence of screening
  - Adenoma
  - Preclinical cancer
  - Death
- National reference centre
- Survey
- Screening registry
- Literature

EARLY DETECTED CANCER
PREVENTED CANCER
Normal result
### Results

**Colorectal cancer burden (source of data: Czech National Cancer Registry)**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
<th>2005</th>
<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of new disease cases</td>
<td>7,479</td>
<td>7,700</td>
<td>8,110</td>
<td>7,905</td>
<td>8,025</td>
<td>8,008</td>
<td>7,771</td>
<td>7,809</td>
<td>8,140</td>
<td>8,093</td>
</tr>
<tr>
<td>Number of deaths</td>
<td>4,454</td>
<td>4,476</td>
<td>4,574</td>
<td>4,424</td>
<td>4,280</td>
<td>4,292</td>
<td>4,335</td>
<td>4,203</td>
<td>4,270</td>
<td>4,115</td>
</tr>
</tbody>
</table>

**Coverage by the screening programme (source of data: NRC)**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
<th>2004</th>
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<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of FOBTs</td>
<td>12,555</td>
<td>167,783</td>
<td>187,644</td>
<td>207,854</td>
<td>228,062</td>
<td>248,272</td>
<td>268,133</td>
<td>315,026</td>
<td>345,866</td>
<td>404,298</td>
</tr>
<tr>
<td>Coverage by screening</td>
<td>0.4%</td>
<td>5.4%</td>
<td>10.5%</td>
<td>11.5%</td>
<td>12.4%</td>
<td>13.4%</td>
<td>14.3%</td>
<td>15.9%</td>
<td>17.9%</td>
<td>18.6%</td>
</tr>
</tbody>
</table>

**Modelled performance of the screening programme (source of data: NRC, IBA MU)**

<table>
<thead>
<tr>
<th>YEAR</th>
<th>2000</th>
<th>2001</th>
<th>2002</th>
<th>2003</th>
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<th>2006</th>
<th>2007</th>
<th>2008</th>
<th>2009</th>
</tr>
</thead>
<tbody>
<tr>
<td>Number of follow-up colonoscopies</td>
<td>405</td>
<td>5,377</td>
<td>6,028</td>
<td>6,676</td>
<td>7,326</td>
<td>7,974</td>
<td>8,626</td>
<td>9,359</td>
<td>12,892</td>
<td>18,211</td>
</tr>
<tr>
<td>Removed advanced adenomas</td>
<td>52</td>
<td>676</td>
<td>763</td>
<td>845</td>
<td>928</td>
<td>1,009</td>
<td>1,097</td>
<td>1,163</td>
<td>1,943</td>
<td>2,858</td>
</tr>
<tr>
<td>aADR (per 1000 FOBTs)</td>
<td>4.1</td>
<td>4.0</td>
<td>4.1</td>
<td>4.1</td>
<td>4.1</td>
<td>4.1</td>
<td>4.1</td>
<td>3.7</td>
<td>5.6</td>
<td>7.1</td>
</tr>
<tr>
<td>Early detected CRCs</td>
<td>27</td>
<td>337</td>
<td>384</td>
<td>424</td>
<td>467</td>
<td>508</td>
<td>552</td>
<td>576</td>
<td>795</td>
<td>974</td>
</tr>
<tr>
<td>CRC detection rate (per 1000 FOBTs)</td>
<td>2.2</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.0</td>
<td>2.1</td>
<td>1.8</td>
<td>2.3</td>
<td>2.4</td>
</tr>
<tr>
<td>Prevented CRCs</td>
<td>0</td>
<td>1</td>
<td>6</td>
<td>13</td>
<td>24</td>
<td>38</td>
<td>54</td>
<td>71</td>
<td>92</td>
<td>118</td>
</tr>
</tbody>
</table>

**5,044 early detected cancers, 417 prevented cancers**
Getting one step further
Utilising nationwide administrative data

Association of Colonoscopy and Death From Colorectal Cancer:
A Population-Based, Case-Control Study

Nancy N. Baxter, MD, PhD; Meredith A. Goldwasser, ScD; Lawrence F. Paszat, MD, MS; Refik Saskin, MSc; David R. Urbach, MD, MSc; and Linda Rabeneck, MD, MPH

Background: Colonoscopy is advocated for screening and prevention of colorectal cancer (CRC), but randomized trials supporting the benefit of this practice are not available.

Objective: To evaluate the association between colonoscopy and CRC deaths.

Design: Population-based, case-control study.

Setting: Ontario, Canada.

Patients: Persons age 52 to 90 years who received a CRC diagnosis from January 1996 to December 2001 and died of CRC by December 2003. Five controls matched by age, sex, geographic location, and socioeconomic status were randomly selected for each case patient.

Measurements: Administrative claims data were used to detect exposure to any colonoscopy and complete colonoscopy (to the cecum) from January 1992 to an index date 6 months before diagnosis in each case patient and the same assigned date in matched controls. Exposures in case patients and controls were

Results: 10,292 case patients and 51,460 controls were identified; 779 case patients (7.0%) and 5021 controls (9.8%) had undergone colonoscopy. Compared with controls, case patients were less likely to have undergone any attempted colonoscopy (adjusted conditional odds ratio [OR], 0.69 [95% CI, 0.63 to 0.74; P < 0.001]) or complete colonoscopy (adjusted conditional OR, 0.63 [CI, 0.57 to 0.69; P < 0.001]). Complete colonoscopy was strongly associated with fewer deaths from left-sided CRC (adjusted conditional OR, 0.33 [CI, 0.28 to 0.39]) but not from right-sided CRC (adjusted conditional OR, 0.99 [CI, 0.86 to 1.14]).

Limitation: Screening could not be differentiated from diagnostic procedures.

Conclusion: In usual practice, colonoscopy is associated with fewer deaths from CRC. This association is primarily limited to deaths from cancer developing in the left side of the colon.

Funding: Canadian Institutes of Health Research and American Society of Clinical Oncology.

Analysis of Administrative Data Finds Endoscopist Quality Measures Associated With Postcolonoscopy Colorectal Cancer

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*Department of Surgery and Keenan Research Centre, Li Ka Shing Knowledge Institute, St Michael’s Hospital, University of Toronto; †Institute for Clinical Evaluative Sciences; ‡Department of Health Policy, Management, and Evaluation, ‖Dalla Lana School of Public Health, and †Department of Medicine, University of Toronto; and †Odette Cancer Centre, Sunnybrook Health Sciences Centre, Toronto, Ontario, Canada
Getting one step further
Utilising nationwide administrative data

**TEST**
- FOBT – codes 15120, 15121
- Primary screening colonoscopy – code 15105

**ASSESSMENT**
- Colonoscopy – codes 15403, 15404, 15101
- RTG - code 89155
- CT, MR – codes 89611, 89613, 89615, 89617, 89619, 89715
- PET, PET/CT - codes 47302, 47351, 47353

**FINAL DIAGNOSIS**
- Polypectomy - codes 15950
- Mucosal resection - codes 15475
- Surgery – codes 51357, 51359, etc.

**TREATMENT**
- Surgery
- Radiotherapy
- Pharmacotherapy

Detection rates
Interval cancers
Effectiveness of screening
Conclusions

- The Czech Republic established organized screening programmes for cancer of breast, colon and rectum, and uterine cervix
- Apart from collection of clinical data from screening centres, the system for information support utilises available data on cancer epidemiology and claims data collected by health care payers
- It is not yet possible to monitor part of recommended indicators due to non-existence of individual linkage between different sources of data
- It is possible to use available data for performance monitoring of screening centres
- Parameters estimated from different sources of data can be used together using mathematical modelling to obtain information on programme quality and effectiveness
- Extensive use of administrative data can lead to more comprehensive system for evaluation of performance and impact indicators
Development of methodology for monitoring of colorectal cancer screening programme is part of project: „Mathematical and statistical models in evaluation of cancer screening programmes“ (MUNI/A/0828/2011)
Masaryk University / Student Project Grant at MU (specific research, rector's programme)
Screening colonoscopy centres, for participation at data collection

Providers of administrative and cancer registry data