A Comparison of International Modelling Methods to Evaluate Health Economics of Colorectal Cancer Screening: A Systematic Review Protocol

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Abstract

Background: Colorectal Cancer (CRC) is becoming an increasing health problem worldwide. However, with the help of screening, early diagnosis can reduce incidence and mortality rates. To elevate the economic burden CRC can cause, cost-effectiveness analysis (CEA) can assist healthcare systems to make screening programmes more cost-effective and prolong survival for early-stage CRC patients. This review aims to identify different CEA modelling methods used internationally to evaluate CRC.

Methods: This review will systematically search electronic databases which include MEDLINE, EMBASE, Web of Science and Scopus. The Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guidance recommendations will design the review and the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) statement will be used to extract relevant data from studies retrieved. Two reviewers will screen through the evidence using the PICOS (Participant, Intervention, Comparators, Outcomes, Study Design) framework, with a third reviewer to settle any disagreements. Once data extraction and quality assessment are complete, the results will be presented qualitatively and tabulated using the CHEERS checklist.

Discussion: The results obtained from the systematic review will highlight how different CRC screening programmes around the world utilise and incorporate health economic modelling methods to be more cost-effective. This information can help modellers develop CEA models which can be adapted to suit the specific screening programmes.

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Background

Colorectal cancer (CRC) is the second most common cancer in females and the third most common cancer in males throughout the world [1]. However, morbidity and early death of CRC can be prevented through early diagnosis via screening. Although extremely beneficial to the public, screening and the subsequent clinical pathways leading from this can be costly. In 2015, it was found that across Europe, colorectal cancer had cost e19.1 billion to the economy [2]. To maximise the survival and long-term effects of the public's health and thus reallocate the cost due to CRC to other parts of the economy, a cost-effective approach is needed to achieve this goal.

Colorectal cancer most commonly develops from polyps in the colon and/or rectum [3]. These polyps can grow within the glandular tissue which is located in the intestinal lining. Polyps are known to develop into precancerous disease via the adenocarcinoma sequence where genetic changes arise [4]. If polys are identified after a positive screening test, they can be removed before they develop into cancer. Tissue samples are typically submitted for histopathological examination to identify if there are any cancerous cells present. The primary aim of CRC screening programmes is to diagnose cancer early. Thus, to reduce the later stages of this disease, screening programmes have been introduced to help tackle this public health problem [1].

CRC screening is subject to the World Health Organisation (WHO) principles of screening, as first discussed by Wilson & Junger [5], whereby understanding the interplay of the harms and benefits of the ability to test for the pre-clinical disease is a necessary step in planning. This has led to the application of cost-effectiveness analyses as a means to carry out evaluations of screening which support decision-makers in their planning and delivery of services. There are a range of modelling methods within this area, however, this may result in conflicting results about the correct course of screening strategy adoption in a given jurisdiction. Improving the understanding of the approaches taken by screening programmes will create greater transparency and context for readers, decision-makers and ultimately patients within screening programmes.

This review protocol will create a comprehensive search of cost-effectiveness analysis modelling methods of colorectal cancer screening programmes used internationally. This information will therefore be used to examine the key attributes of a cost-effectiveness model and support the use of findings in future to build more efficient models, grounded in real-world data for application in screening programmes worldwide.

Methods

The protocol of this systematic review adheres to the Preferred Reporting Items for Systematic Reviews and Meta-Analysis Protocols (PRISMA-P 2015) [6] guidelines (see Additional file 1). The protocol is also registered in the PROSPERO database, the International prospective register of systematic reviews (CRD42022296113).

The PRISMA [7] guidance recommendations have been used to design the systematic review. The systematic review will apply the Consolidated Health Economic Evaluation Reporting Standards (CHEERS) [8] statement to extract relevant data from studies retrieved.

Decision Problem Review Question

The objective of this review is to identify the modelling methods and assumptions used for colorectal cancer screening globally and to derive cost-effective analysis / cost-utility analysis / cost-benefit analysis outcomes. The following specific questions will be addressed in the review.

1. What is the model structure (for example, Markov, Semi-Markov, Discrete event simulation) used in a particular colorectal cancer screening programme?

2. What are the model assumptions for each model structure e.g., time horizons, LYGs, QALYs, costs and other parameters?

3. What is the associated background mortality with the population used for the building of this model? Are other model parameters included, such as efficiency parameters?

Defining inclusion criteria

• Participants - Individuals eligible to receive a colorectal cancer screening invitation.

• Interventions - Interventions for screening for colorectal cancer, for example, faecal immunochemical test (FIT), faecal occult blood test (FOBT), flexible sigmoidoscopy, colonoscopy, computed tomography colonography (CTC), double-contrast barium enema, or any other screening methods, which are not included in this list.

• Comparators - Age range of the screening population and thresholds associated with quantitative FIT testing and FOBT testing.

• Outcomes - incremental cost-effectiveness ratio (ICER), net-benefit, life-years gained (LYGs), quality-adjusted life-years (QALYs), costs, colonoscopy utilisation or any other unit of health gain and screening harm.

• Study Designs - All economic evaluation academic papers which are published and discuss an economic evaluation model are eligible for inclusion in the review.

Defining exclusion criteria

• Participants - Only human patients to be included in the papers and not animals.

• Interventions - Interventions used outside of the interventions listed above.

• Study Designs - To avoid potentially high bias, case reports and case series are excluded from this review. Randomised controlled trials and cohort studies are needed for the quality evaluation of models but are not directly necessary for this review.

• Time frame - Academic papers published between January 2011 and December 2021.

Identifying research evidence

The search strategy was optimised from advice by the Specialist Medical Librarian at the host institution, who suggested using several databases to meet the needs of the review. The databases used for the planned strategy were MEDLINE, EMBASE, Web Of Science and Scopus. Searches were conducted in December 2021 using the

MESH search terms (see Additional File 2), and updated in January 2022 for the following:

1. Colorectal Neoplasms OR colorectal cancer OR bowel cancer OR colorectal

2. screen* OR Mass Screening

3. Cost-Benefit Analysis OR cost-effective* OR cost-utility OR quality-adjusted life-years OR life-year* gain* OR economic evaluat* OR health technology assessment OR incremental cost-effective* ratio* OR ICER* OR cost analys* OR qaly* OR lyg*

Searches 1, 2 and 3 are then combined by AND. Only English papers were included in this review since there was no funding to translate non-English language papers. The studies which fulfil this criterion were then screened for inclusion by the PICOS criteria.

Study Selection

There will be three stages in the study selection process.

1. All results found from the initial search will be downloaded into COVIDENCE systematic review manager [9] to facilitate the review management, including the removal of duplicated articles before starting the title and abstract review.

2. The titles and abstracts of the papers will be screened by two reviewers following the PICOS criteria.

3. The full text of the eligible papers will be reviewed to further confirm their eligibility.

If the two reviewers disagree on papers, a third reviewer will be introduced and a consensus of the three reviewers will be made. Also, in the case that multiple papers report the same model/method, the most recent paper with the overall model structure will be included, thus resulting in other papers with this model being discarded. The papers excluded will be deemed ineligible according to the PICOS criteria.

A sample of papers will be used to pilot the selection process using the inclusion criteria, to determine whether papers are being selected appropriately. If any noticeable or fundamental changes need to be addressed to the inclusion criteria, they can be iteratively improved by the reviewers to support the objectives.

Data Extraction

The data extraction process will apply the CHEERS checklist for quality reporting of economic evaluations, as recommended by the EQUATOR Network [10]. The extracted data will mirror the expected format of this standard for reporting and use this to benchmark and guide the collation of data. The data extraction focuses on the model design, parameter selection, modelling methods - to examine best practices and understand the sources of variation in methods, the likely impact on study quality, and therefore its appropriateness for future application.

Quality assessment

Papers eligible to move on from the initial screening of the searches will undergo quality assessment, where detailed information on study characteristics will be collected, based on the CHEERS guidelines checklist.

Data Synthesis

To document the study selection process, a PRISMA flow chart showing the number of papers remaining at each stage will be presented.

As the purpose of this review was to examine the modelling methods used to evaluate the health economics of colorectal cancer screening, the results will be presented qualitatively. The studies included in the final review will be tabulated by the CHEERS checklist. Some key features will include the type of study, outcome measure and the interventions included. Thus, methodological study quality will be addressed, for example, the economic model choice, effectiveness measure, and cost measures. Examination of the results will also collate to any sensitivity analyses performed in the studies to help identify if there are any changes to the study conclusions due to the susceptibility of cost-effectiveness to key model parameters.

Dissemination

Results found from this systematic review will be published in a peer-reviewed journal and disseminated at international conferences and institutional academic workshops.

Discussion

Earlier diagnosis of colorectal cancer as a result of screening can result in improved treatment and survival outcomes. To achieve this goal, healthcare providers can use health economic modelling methods to develop a more cost-effective approach to tackling CRC screening and tailor the methods specifically to other countries. This review will collate the modelling methods and assumptions used in CRC screening programmes internationally and thus can be a guide for modellers, for future design and to illustrate improvements, standardisation and quality evaluation of the models used within screening programmes to date.

In this systematic review protocol, the papers will be screened using the PICOS framework, while the data extraction and quality assessment will follow the CHEERS checklist [8]. One limitation to this review, which may result in publication bias, is that only English language papers will be used since there is no funding for non-English papers to be translated. During the data synthesis process, the results will be qualitatively reported and tabulated with the help of the CHEERS checklist. It is hoped that the findings will give modellers and policymakers better insight into the modelling methods available within colorectal cancer screening, and how best to tailor such models for a defined population.

Abbreviations

CRC
Colorectal Cancer
CEA
Cost-effectiveness Analysis
PRISMA
Preferred Reporting Items for Systematic Reviews and Meta-Analysis
CHEERS
Consolidated Health Economic Evaluation Reporting Standards

PICOS
Participants, Interventions, Comparators, Outcomes, Study Designs
WHO
World Health Organisation
LYGs
Life Years Gained
QALYs
Quality Adjusted Life Years
FIT
Faecal Immunochemical Test
FOBT
Faecal Occult Blood Test
CTC
Computed Tomography Colonography
ICER
Incremental Cost-Effective Ratio.

Declarations

Ethics approval and consent to participate

Not applicable.

Consent for publication

Not applicable.

Availability of data and materials

Not applicable.

Competing interests

The authors declare that they have no competing interests.

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Author's contributions

The idea for this systematic review was suggested by FL and EMcF. The development of this review was helped by ML, TO and CMcK. OA undertook the role of lead author for this review. OA constructed the protocol strategy, with input from EMcF, FL, TO, ML, and CMcK. The manuscript was approved by all the authors.

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Supplementary Files

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- AdairPRISMAPchecklist.docx
- AdairMESHSearchTerms.pdf