Institution: University of Sheffield		
Unit of Assessment: A-02 Public Health, Health Services and Primary Care		
Title of case study: Refining the national bowel cancer screening programme to optimise population outcomes		
Period when the underpinning research was undertaken: 2010–2016		
Details of staff conducting the underpinning research from the submitting unit:		
Name(s):	**Role(s) (e.g. job title):**	**Period(s) employed by submitting HEI:**
James Chilcott	Professor of Healthcare Operational Research	1996–present
Ben Kearns	Research Fellow	2011–present
Olena Mandrik	Research Fellow	2018–present
Alison Scope	Research Associate	2013–present
Paul Tappenden	Professor of Health Economic Modelling	2000–present
Chloe Thomas	Research Fellow	2014–present
Sophie Whyte	Senior Research Fellow	2007–present
Period when the claimed impact occurred: 2016–2020		
Is this case study continued from a case study submitted in 2014? N		

1. Summary of the impact (indicative maximum 100 words)

Bowel cancer screening is estimated to save around 2,400 lives per year and reduces NHS costs. Sheffield research evaluated different options for the bowel cancer screening programme including the optimal design for repeated Faecal Immunochemical Test (FIT) screening. This research directly informed the 2016 UK National Screening Committee recommendation to replace the guaiac occult blood test (gFOBt) with the FIT. UK roll-out of FIT screening began in 2017. Moving to FIT results in higher participation (59% to 66%) and higher levels of detection. Projections suggest that moving from gFOBt to FIT enables a lifetime reduction of cancer related mortality of 8%. The overall net monetary benefit is estimated as £107.3m.

2. Underpinning research (indicative maximum 500 words)

Bowel cancer is the third most common cancer with approximately 41,000 diagnoses and 16,000 deaths each year in the UK. Bowel cancer screening has reduced morbidity and mortality. The School of Health and Related Research (ScHARR) at the University of Sheffield has been working with the Department of Health and Social Care (DHSC), Public Health England and UK National Screening Committee (NSC) since 2004 to support evidence-based policy making in bowel cancer screening.

Bowel cancer screening is a complex intervention with multiple components. Sheffield research focuses upon the development of mathematical models of the bowel cancer screening system, including disease natural history, diagnosis, treatment and surveillance, and the application of these models to inform policy decisions. Between 2010-2012 ScHARR undertook a reappraisal of bowel cancer screening options on behalf of NHS Cancer Screening Programmes. This involved collaboration to incorporate data from clinical trials and routine screening data. Model results suggested that screening strategies involving Flexible Sigmoidoscopy (FS) or FIT may

produce additional benefits compared with the existing biennial guaiac occult blood testing (gFOBT) screening strategy as they are both more sensitive tests. The age at which a single FS screen results in the greatest quality-adjusted life year gain was 55. Strategies which combined FS and FIT showed further benefits and improved economic outcomes. These results were not obtainable from trials alone and required our modelling [R1, R2].

FS screening for 55-year-olds (in addition to repeated gFOBT) was introduced in 2013 under the name 'bowel scope screening'. Due to capacity constraints bowel scope screening is not yet available in all areas of the UK. Uptake was low at 43% and there were some differences in detection rates compared to the trial setting.

In 2016 Sheffield researchers were funded by the UK NSC to undertake further research drawing on data from the bowel scope screening programme. The first research phase considered the cost-effectiveness and endoscopy capacity requirements of a variety of different screening options incorporating FIT [R3], based on modelling using ScHARR's validated model [R4]. The second phase of the research developed a new version of the model which uses a patient level simulation approach to enable evaluation of the impact of screening on health inequalities and the evaluation of targeted and personalised screening strategies.

Our analysis showed that FIT is a cost-effective test to use in the bowel screening programme. The ideal age to start is at 50/51 years, recommended screening interval was two years and the FIT threshold should be 20 µg/g (or as low as possible with available colonoscopy capacity) [R3].

The key constraint limiting further optimisation of the UK Bowel Cancer Screening Programme (BCSP) is NHS colonoscopy capacity, with screening referrals to colonoscopy competing with cancer investigations and surveillance in the symptomatic and previously treated populations. In light of this constraint, the British Society of Gastroenterology (BSG) commissioned a review of surveillance guidelines, resulting in the 2018/19 guidelines for surveillance post-polypectomy/colorectal resection from the BSG, the Association of Coloproctology of Great Britain and Ireland (ACPGBI) and Public Health England (PHE). A systematic review was undertaken by ScHARR to support this Guideline development and found that patients with low risk adenomas are not at increased risk of bowel cancer compared to patients with no adenomas detected at colonoscopy. Dr Whyte acted as a Member of the BSG guideline development group playing a key role as the only health economist in the group [R5].

3. References to the research (indicative maximum of six references)

(University researchers in **bold**)

R1. **Whyte, S.,** Walsh, C., & **Chilcott, J.** (2011). Bayesian Calibration of a Natural History Model with Application to a Population Model for Colorectal Cancer. *Medical Decision Making, 31*(4), 625–641. https://doi.org/10.1177/0272989x10384738

R2. **Whyte, S., Chilcott, J.,** & Halloran, S. (2012). Reappraisal of the options for colorectal cancer screening in England. *Colorectal Disease, 14*(9), e547–e561. https://doi.org/10.1111/j.1463-1318.2012.03014.x

R3. **Whyte, S.**, **Thomas, C.**, **Kearns, B.**, **Webster, M.**, **Chilcott, J.** (2018). *Optimising Bowel Cancer Screening Phase 1: Optimising the cost effectiveness of repeated FIT screening and screening strategies combining bowel scope and FIT screening*. Report prepared for

the UK NSC. The University of Sheffield, 25 June 2018. Available at: https://legacyscreening.phe.org.uk/bowelcancer

R4. **Thomas, C., Whyte, S., Kearns, B.,** & **Chilcott, J. B.** (2019). External Validation of a Colorectal Cancer Model Against Screening Trial Long-Term Follow-Up Data. *Value in Health, 22*(10), 1154–1161. https://doi.org/10.1016/j.jval.2019.06.005

R5. Rutter, M. D., East, J., Rees, C. J., Cripps, N., Docherty, J., Dolwani, S., Kaye, P. V., Monahan, K. J., Novelli, M. R., Plumb, A., Saunders, B. P., Thomas-Gibson, S., Tolan, D. J. M., **Whyte, S**., Bonnington, S., **Scope, A., Wong, R.,** Hibbert, B., Marsh, J., … Sharp, L. (2019). British Society of Gastroenterology/Association of Coloproctology of Great Britain and Ireland/Public Health England post-polypectomy and post-colorectal cancer resection surveillance guidelines. *Gut, 69*(2), 201–223. https://doi.org/10.1136/gutjnl-2019-319858

4. Details of the impact (indicative maximum 750 words)

Sheffield research provided key evidence to inform national policy recommendations and implementation of bowel cancer screening in the UK. Refining and optimising bowel cancer screening programmes from gFOBT to FIT enables the NHS to save costs, reduce cancer morbidity, save lives and in some cases prevent potential harm associated with screening.

Change in policy and practice

Our work on optimising the design of the FIT based screening programme directly informed the recommendations of the UK NSC. In January 2016, the UK NSC recommended a change to the primary test used in the NHS Bowel Cancer Screening Programme from gFOBt to FIT [S1]. In August 2018, following further review of the evidence, the UK NSC recommended that FIT is offered at 50-74 years at as low a threshold as possible [S1]. Sheffield research is directly cited in the evidence used to inform these recommendations [S1].

The introduction of FIT into the screening programme provides further opportunity to detect and prevent more cancers. The benefits of using FIT are that:

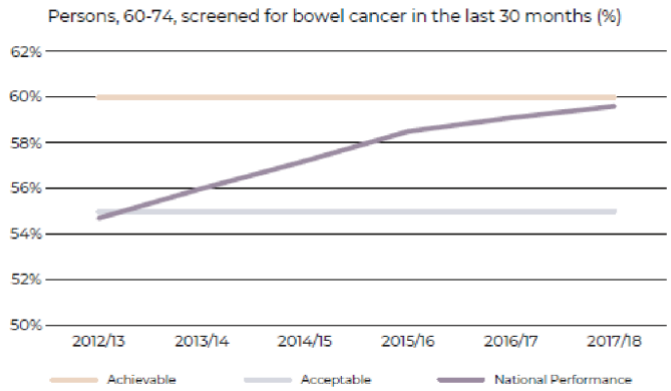
- it is easier to use and can be measured more reliably using a machine rather than the human eye;
- the increased sensitivity enables FIT to detect more pre-cancer lesions;
- FIT requires a single faecal sample and is more acceptable to people invited to screening;
- FIT is a cost-effective alternative to gFOBt [S1].

Following the recommendations of the UK NSC, FIT was rolled out across the UK [S2]:

- In Scotland, FIT replaced gFOBt as the test for bowel screening in November 2017 (ages 50-74, threshold 80 µgHb/g faeces).
- In England, FIT was introduced in June 2019 (ages 60-74, threshold 120 µgHb/g faeces).
- In Wales FIT started to replace gFOBt through a phased roll out, with 1 in 28 people receiving the new kit from the end of January 2019, (ages 60-74, threshold 150 µgHb/g faeces).
- In Northern Ireland, the Department of Health announced on 11 April 2019 to roll out FIT from early 2020, (ages 60-74).

Improving patient health outcomes and cost savings to the NHS

The 'Report of the Independent Review of Adult National Screening Programmes in England' (October 2019) for NHS England indicates that bowel cancer screening is estimated to save around 2,400 lives per year. In 2017/18, 4.4m people were invited for screening with 2.5m people screened. This represents an increase in bowel cancer screening since 2016/17 [S3].



Source: [S3] Report of the Independent Review of Adult National Screening Programmes in England, p.65

Data from the first 12 months of FIT screening in Scotland showed an increase in uptake from 55.4% for gFOBT up to 63.9% for FIT. In Scotland the biggest improvement in participation with FIT has been amongst those living in the most deprived areas – up from 42.0% to 51.8% [S4]. FIT has the potential to reduce health inequalities due to higher uptake in more deprived subgroups.

Data from the first 6 months after FIT screening began in England, indicates that between 1 July 2019-30 September 2019 that the proportion of men and women aged 60-74 invited to participate in bowel cancer screening that adequately participate is 67.5% and between 1 Oct 2019-31 December 2019 this is 64.5% [S5]. Uptake from the first 6 months is in line with earlier predictions made in the modelling.

The impact on patient outcomes cannot be fully demonstrated in a short timeframe as screening that results in the prompt removal of precancerous conditions may prevent the future CRC (colorectal cancer) incidence and mortality. However, our model predictions for England show that the move from gFOBT to FIT (with 40% also offered Bowel Scope screening) is predicted to be associated with a net monetary benefit of £107.3m; quality adjusted life year gains, 4,006; lifetime reduction in bowel cancer 8%; lifetime reduction in CRC mortality, 8%; reduction in late stage incidence, 8% [S6]

Surveillance of persons following screening colonoscopy

The British Society of Gastroenterology (BSG) adenoma surveillance guidelines were updated in November 2019 and are NICE compliant. The new guidelines recommend a reduction in surveillance for persons who are at a low risk of CRC. These new guidelines will reduce unnecessary colonoscopies and harm, save NHS money, and free up endoscopy capacity to be better used elsewhere. It is possible that by reducing the endoscopy requirements for adenoma surveillance and symptomatic referrals could enable expansion of the FIT screening programme.

While it is still early to assess the direct effects of the new guidelines, modelling undertaken by St George's University Hospitals NHS Foundation Trust provide an estimate of the potential cost savings and capacity that could be generated, *"Implementing the 2019 guideline will lead to an annual cost saving of £75,159 to £87,699, depending on the number of patients <45 years old offered colonoscopy surveillance, and generate capacity for 177 to 207 additional colonoscopies per year"* [S7].

Informing international policy and practice

Sheffield research is included in the International Handbook of Cancer Prevention by the International Agency for Research on Cancer (IARC) of the World Health Organisation, 2019. The IARC Handbooks evaluate the published scientific evidence of cancer-preventive interventions and provide authoritative information about cancer research [S8].

Dr Whyte contributed to the World Endoscopy Organization (WEO) international delphi consensus process which led to the publication of Principles for Evaluation of Surveillance After Removal of Colorectal Polyps [S9].

5. Sources to corroborate the impact (indicative maximum of 10 references)

S1. The UK NSC recommendation on bowel cancer screening in adults, August 2018 https://legacyscreening.phe.org.uk/bowelcancer (ScHARR's optimising bowel cancer screening research is directly referenced as part of the key findings supporting the recommendation).

S2. Reports relating to the roll-out of FIT from 2017 to 2019 in Scotland, England and Wales (http://bit.ly/3vQMnHs) and Northern Ireland (http://bit.ly/3setFaG).

S3. Richards, M 'Report of the Independent Review of Adult National Screening Programmes in England'. Prepared for NHS England, October 2019. Available at: https://bit.ly/30UOiwp

S4. Bowel Cancer UK. 'New bowel screening test leads to increase in uptake in Scotland'. 5 Feb 2019. https://bit.ly/2OGlkxO.

S5. Public Health England. NHS screening programmes: KPI reports 2019-2020. Published 08 Jan 2020. Young person and adult screening KPI data:Q2 (1 Jul 2019 to 30 Sep 2019) and Young person and adult screening KPI data:Q3 (1 Oct to 31 Dec 2019). https://www.gov.uk/government/publications/nhs-screening-programmes-kpi-reports-2019-to-2020

S6. Sheffield modelling spreadsheet.

S7. Shandro, B., et. al. (2020). Real-life cost savings and capacity improvements on implementation of the new BSG post-polypectomy surveillance guideline. *Clinical Medicine, 20*(1), 116–117. https://doi.org/10.7861/clinmed.2019-0401 [article also includes a link to the Rutter et al BSG updated guidelines].

S8. IARC (2019). *Colorectal cancer screening*. IARC Handb Cancer Prev. 17:1–300. Page references: p.115, 119, 125, 127, 173, 179, 181, 184. http://publications.iarc.fr/573

S9. Rutter, M. D., et. al. (2020). Principles for Evaluation of Surveillance After Removal of Colorectal Polyps: Recommendations From the World Endoscopy Organization. *Gastroenterology, 158*(6), 1529–1533.e4. https://doi.org/10.1053/j.gastro.2019.12.052