Institution: University of Nottingham

Unit of Assessment: UoA1

Title of case study:
Saving lives through faecal occult blood screening for bowel cancer

1. Summary of the impact

The Nottingham Bowel Cancer Screening trial showed that biennial Faecal Occult Blood testing reduced bowel cancer mortality by 16%. As a consequence of this trial, the Department of Health launched two screening pilots and introduced a National Bowel Cancer Screening Programme (NBCSP), achieving national coverage in 2010. Since 2008, this has sent out almost 18 million invitations and detected 16,000 bowel cancers, of which 21.6% were early cancers with a 95% chance of cure. It is estimated that the NBCSP saves around 3,500 lives each year in the UK. International screening programmes modelled on the UK system will save many more.

2. Underpinning research

Around one in 20 people in the UK will develop bowel cancer during their lifetime. The disease kills around 16,000 people each year in the UK, and around 608,000 worldwide – mainly because it has non-specific symptoms and thus presents at a late stage. Bowel cancers tend to develop slowly from colonic polyps over a period of 10-15 years. Removal of these polyps at colonoscopy can prevent the polyp from becoming a cancer. Furthermore, the slow development of bowel cancers means they can often be detected at an early stage, when they are easier to treat. These characteristics make bowel cancer an excellent candidate for a population screening programme. Faecal Occult Blood (FOB) testing can detect polyps on the lining of the bowel, and also early-stage bowel cancers.

Professor Jack Hardcastle (University of Nottingham) designed and ran the Nottingham Bowel Cancer Screening Trial until his retirement in 1996, when Professor John Scholefield (also University of Nottingham) took over. The trial stopped recruiting in 1995, and follow up of the trial populations continued until 2009.

The Nottingham trial randomised over 150,000 individuals (aged over 60) in the Nottingham area, by household, to receive either biennial FOB tests or no intervention. It showed a 16% reduction in bowel cancer mortality [1,2], which was maintained in follow up to 2009 [3]. The proportion of early-stage cancers (Dukes Stage A) detected in the screened groups was 26%, compared with 13% in the control population. Follow up of the Nottingham cohort also showed that there is a small reduction in incidence of bowel cancer (due to removal of large polyps after positive FOB tests) after a median of 18 years of follow up [3], although the sample size was too small to enable extrapolation to numbers of cancers prevented.

Our group has shown that the health economic benefits (cost per quality-adjusted life year [QALY]) of FOB screening for bowel cancer are similar to those for breast cancer screening in the short term [4]. Over the longer term, the estimates for bowel cancer screening were superior to those for breast cancer screening [4]. QALYs are a measure of disease burden used to assess the value of a medical intervention. They are based on the number of years of life, and the quality of these years, that would be added by the intervention. One QALY is one year spent in perfect health.

Population screening with FOB tests is simple, cheap and effective, usually detecting bowel cancers before they would present symptomatically. A guaiac-based test can be used in conjunction with an immunochemical test to help increase sensitivity of FOB screening. Furthermore, automation of the test allows manipulation of sensitivity and increased throughput [5].

3. References to the research

1. **Hardcastle JD**, Chamberlain JO, Robinson MH, Moss Sm, Amar SS, Balfour TW, James PD, Mangham CM. Randomised controlled trial of faecal occult blood screening for colorectal cancer. Lancet 1996;348:1472-1477
http://dx.doi.org/10.1016/S0140-6736(96)03386-7

2. Whynes DK, Mangham CM, Balfour TW, **Scholefield JH**. Analysis of deaths occurring within the Nottingham trial of faecal occult blood screening for colorectal cancer. Gut 2010 Aug;59(8):1088-1093
http://dx.doi.org/10.1136/gut.2009.192971

3. **Scholefield JH**, Moss SM, Mangham CM, Whynes DK, **Hardcastle JD**. Nottingham trial of faecal occult blood testing for colorectal cancer: a 20-year follow-up. Gut 2012;61(7);1036-1040
http://dx.doi.org/10.1136/gutjnl-2011-300774

4. Whynes DK, Neilson AR, Walker AR, **Hardcastle JD**. Faecal occult blood screening for colorectal cancer: is it cost-effective? Health Economics 1998, 7: 21-29
http://dx.doi.org/10.1002/(SICI)1099-1050(199802)7:1<21::AID-HEC306>3.0.CO;2-9

5. **Scholefield JH**. Immunochemical testing for colorectal cancer. Lancet Oncol. 2006 Feb;7(2):101-103
http://dx.doi.org/10.1016/S1470-2045(06)70549-6

Grants
The Nottingham Bowel Cancer Screening Trial has been funded by the MRC over a period of 24 years. Grants covering research from 1993 include:

- 1989-1995: £186,000 (MRC) to JD Hardcastle 'Population screening for colorectal cancer – a randomised trial'
- 1995-1999: £142,000 (MRC) to JD Hardcastle 'A randomised trial of population screening for colorectal cancer'
- 1999-2005: £237,000 (MRC) to JH Scholefield 'Follow up of the Nottingham Screening trial'
- 2006-2012: 135,000 (MRC) to JH Scholefield 'Follow up of the Nottingham Screening trial'

4. Details of the impact

Establishment of Bower Cancer Screening Programmes across the world
The Nottingham trial is one of four randomised trials of population-based screening worldwide in support of bowel cancer screening with the Faecal Occult Blood (FOB) test [a]. Professor Hardcastle was also instrumental in setting up the Danish study that constitutes another of these four trials [a].

The results from the Nottingham Bowel Cancer Screening trial [1] led to the development of NHS screening pilots for bowel cancer in Coventry and Tayside in 1998. Professors Hardcastle and Scholefield advised the Department of Health, and thereby influenced the design and operation of the pilots and, through these, the National Bowel Cancer Screening Programme itself [a]. Professor Scholefield served on the National Bowel Cancer Screening Advisory Board from its inception in 2007 to present and, in 2012, became Chair of this Advisory Board. Professor Scholefield is also Chair of the Research and Audit Committee for the National Bowel Cancer Screening Programme (2008 to present).

The results of the screening pilots were similar to the Nottingham trial, showing a 16% reduction in bowel cancer mortality compared with no intervention, and a doubling in the proportion of

early-stage cancers detected. This led to the introduction of a National Bowel Cancer Screening Programme, modelled on the Nottingham criteria for population screening [b]. Roll out of the Programme achieved national coverage in 2010. This involved establishing 5 dedicated screening hubs (one of which is in Nottingham), based in secondary care, serving a potential population of 10 million people. The hubs send out, process and arrange colonoscopies in over 70 national endoscopy units.

The Nottingham work on FOB screening influenced the introduction of bowel cancer screening programmes not only in the UK, but also around the world [a]. Since 2008, similar programmes of bowel cancer screening using FOB tests have either been rolled out or achieved national coverage in Northern Ireland, Scotland and Wales [c]. National bowel cancer screening programmes modelled on the UK system using FOB tests are also being developed and implemented in Canada [d], Denmark (committed in 2013 to introducing a programme in 2014) [e] and Australia [f]. Some of this commitment will undoubtedly have been influenced by the 'European Guidelines for Quality Assurance in Colorectal Cancer Screening and Diagnosis', the first edition of which was published in 2010 [g]. This publication aims to ensure appropriate quality assurance at all levels when performing bowel cancer screening. Our Nottingham research is repeatedly cited in these guidelines as evidence for the effectiveness of FOB screening.

Prevention and early detection of bowel cancers

Since 2008, the National Bowel Cancer Screening Programme in England has sent out almost 18 million invitations and detected 16,000 early cancers [h]; around 2,000 per annum. Of these, 21.6% were Dukes stage A - early cancers with a 95% cure rate by surgical resection alone. Before FOB screening became available, only 10-14% of bowel cancers detected in symptomatic populations were Dukes stage A [The Lancet 1993;342(8865),241]. Regular bowel screening thereby increases the detection of early-stage cancers and also reduces the risk of dying from bowel cancer by 16% [1,b], equating to around 3,500 lives saved in the UK per annum.

Follow up of the Nottingham cohort has also shown that there is a small reduction in incidence of bowel cancer (due to removal of large precancerous polyps after positive FOB tests), although the sample size was too small to enable extrapolation to numbers of cancers prevented [3].

Health economic benefits

The health economic benefits of FOB screening for bowel cancer are around £1,600 per QALY (quality-adjusted life year) gained [i], much lower than the cost per QALY gained for breast cancer screening (£20,800) [BMJ 2013; 346:f2618]. This means that compared with no screening, FOB-based population screening would cost the NHS £1,600 for every extra year of perfect health provided.

Impact on other bowel screening methods

Through proving the suitability of bowel cancer for a national screening programme, and showing that lives would be saved through such a programme, our work has paved the way for the development of new screening techniques, such as flexible sigmoidoscopy. The current pilot of flexible sigmoidoscopy is also dependent on the infrastructure that has been established for FOB screening; it is being run from the same five screening hubs and is using the same call and recall systems. Incremental cost effectiveness analysis [j] has reported that the most cost effective strategy is to give flexible sigmoidoscopy at age 55, followed by biennial iFOB screening for ages 56-74 year olds. This approach requires six times as many screening colonoscopies as the current programme, and the NHS does not yet have the skilled personnel nor endoscopic facilities required to provide population screening by flexible sigmoidoscopy. In the meantime, the current programme of biennial FOB screening for ages 60-74 will remain the sole method used in the National Bowel Cancer Screening Programme.

5. Sources to corroborate the impact

[a] Letter from Professor J Patnick CBE, Director of NHS Cancer Screening Programmes.

[b] National Bowel Cancer Screening Programme (England):
http://cancerscreening.nhs.uk/bowel/index.html

[c] FOB screening programmes in the UK:
Northern Ireland: http://www.cancerscreening.hscni.net/1995.htm
Scotland: http://www.nsd.scot.nhs.uk/documents/annreports09-10/bowelsc09-10.pdf
Wales: http://www.wales.nhs.uk/sites3/docopen.cfm?orgid=747&id=182730

[d] Bowel Cancer Screening Programme in Canada:
http://www.cancerview.ca/idc/groups/public/documents/webcontent/cancer_snapshot_10.pdf

[e] Bowel Cancer Screening Programme in Denmark (page last modified February 2013):
http://www.cancer.dk/international/english/Screening+colon+cancer+english/

[f] Bowel Cancer Screening Programme in Australia:
http://www.cancerscreening.gov.au/internet/screening/publishing.nsf/Content/bowel-about

[g] Segnan N, Patnick J and von Karsa L (eds.) (2010) *European Guidelines for Quality Assurance in Colorectal Cancer Screening and Diagnosis,* 1st edition, Luxembourg: Publications Office of the European Union. Available on request.

[h] Email correspondence from Claire Nickerson, Project Manager, NHS Cancer Screening Programmes.

[i] Macafee DA, Waller M, Whynes DK, Moss S, **Scholefield JH**. Population screening for colorectal cancer: the implications of an ageing population. Br J Cancer. 2008 Dec 16;99(12):1991-2000.
http://dx.doi.org/10.1038/sj.bjc.6604788

[j] ScHARR report (see pages 40-42):
http://www.cancerscreening.nhs.uk/bowel/scharr-full-report-summary-201202.pdf