A microsimulation study of the benefits and costs of screening for colorectal cancer

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Declaration

Except where it is otherwise indicated, the work in this thesis is my own, and is based on original research conducted at the National Centre for Epidemiology and Population health, The Australian National University.

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This revised version of the thesis incorporates minor amendments as suggested by the examiners.

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Abstract

This thesis examines the benefits and costs of screening for colorectal cancer in the context of an organised population screening programme. It uses microsimulation modelling to derive an optimally cost-effective screening protocol for various combinations of the available screening tests.

First a mathematical model for the natural history of colorectal cancer is derived, based on analyses of Australian population and hospital-based cancer registries combined with data from published studies. Then a model for population based screening is derived based mainly on data from published screening studies, including the four major published randomised controlled trials of faecal occult blood test (FOBT) screening. These two models are used to simulate the application of a screening programme to the Australian population. The simulations are applied to a period of 40 years following 1990 (the study's base year), with both costs and benefits discounted back to the base year at an annual rate of 3%.

The models are applied to simulating a population screening programme based on FOBT with a colonoscopy follow up of positive tests. This simulation suggests that the optimal application of such a programme would be to offer annual screening to people aged 50 to 84 years. Such a programme would lead to a cumulative fall in years of life lost to colorectal cancer (YLL) of 28.5% at a cost per year of life saved (YLS) of $8,987. These costs and benefits are consistent with those arising from other currently funded health interventions. They are also consistent with the cost per YLS which Australian governments appear willing to pay for health interventions when justified on the basis of cost-effectiveness. The fall in colorectal cancer deaths from this screening programme should be first detectable by a national monitoring system after around three years of screening. However the full benefits from screening would not be realised before around 30 years of screening.

These simulations are based on the standard guaiac FOBT, but the results suggest that significant cost-effective gains could be made by using the newer immunochemical FOBT. Further cost-effect gains could be made by offering sigmoidoscopy every five years in addition to annual FOBT.

The models are then applied to simulating population screening programmes using colonoscopy and sigmoidoscopy as primary screening tools. Offering colonoscopy every ten years to all people aged from 45 to 85 leads to an overall fall in cumulative YLL of 37.6%, at a cost of $15,585 per YLS. Offering sigmoidoscopy every three years to all people aged 40 to 85 leads to an overall fall in cumulative YLL of 29.1%, at a cost of $4,862 per YLS. Both of these cost and benefit results are also consistent with the cost per YLS which Australian governments appear willing to pay. The fall in deaths with colonoscopy screening would also be detectable after three years of screening but the fall with sigmoidoscopy screening would not be detectable until after six years of screening. Sigmoidoscopy would need around 35 years of

screening to reach its potential gains while colonoscopy screening would not reach its full potential during the 40 year screening period.

Finally the models are applied to targeting people at higher risk of cancer. The results show that offering colonoscopy every five years to people at higher risk because of a family history of colorectal cancer is a cost-effective addition to the annual FOBT screening programme.

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Stevenson CE 1995. Statistical models for cancer screening. *Statistical Methods in Medical Research*; 4: 19–23.

An expanded version of chapter two, along with parts of chapter one, has been published as

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