



WCISU OCCASIONAL REPORT

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Projection of incidence and mortality for cancer of the large bowel to 2015

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1. BACKGROUND & AIM OF REPORT

A major benefit of the cancer registration process is the accumulation of a consistent population based database of incidence and mortality spanning several decades. Data for Wales as a whole has been collected since 1974. The Cancer Services Coordinating Group (CSCG) was set up in Wales in 1997 with the aim of implementing the recommendations for improving cancer services outlined in the Calman/Hine and Cameron reports. Early on it was realised that high quality information, together with senior level clinical involvement in interpretation, would be pivotal to success in this sphere.

The Welsh Cancer Intelligence & Surveillance Unit (WCISU) was also set up in 1997, incorporating the former Wales Cancer Registry but with a wider analytical role focussed on modern informatics and statistical analysis. This report is part of our Cancer Intelligence remit for the Welsh Assembly Government and its immediate objective is to provide projections to facilitate the completion of a Pilot Project to develop cancer scenarios specific to Wales. This involves using the available cancer database to project into the future and make estimates of cancer incidence and mortality in the next decade. This work has been carried out by the Analysis Team at WCISU. Clearly this is an inexact science, but by capturing what information we have in the database on past and current trends, by age group, birth cohort and calendar period, and applying an appropriate statistical model, it is hoped these are as accurate as humanly possible.

The topic addressed here is large bowel cancer which is currently subject of a National Service Framework (NSF) and it relates to a Pilot Project developed under the auspices of CSCG, between Dr John Steward, Director WCISU and Dr Iain Robbe, the Public Health Academic lead on CSCG. The overall aim is to derive realistic scenarios for large bowel cancer services up to 2015 in order to inform the final NSF. We are broadly following the Scottish Methodology which also utilises projections based upon APC modelling. In the wider project, Dr Robbe will network with expert clinical opinion which, when combined with the evidence derived here from the observed data, will ultimately provide the most realistic scenarios and a sound background for

decision making regarding the Welsh Assembly Government (WAG) policy in this vital area of cancer control.

2. METHODS

Data for all cases of colon and rectal cancers (colon cancer: ICD-8/ICD-9 codes 1530-1539, ICD-10 codes C180-C189, rectal cancer: ICD-8/ICD-9 codes 1540-1541, ICD-10 codes C19-C20) for the period 1974-2003 for those subjects aged 35 or over at diagnosis were extracted from the database held at the Welsh Cancer Intelligence & Surveillance Unit, Cardiff (WCISU). Corresponding mortality data for the same period was obtained through the Office for National Statistics (ONS). The cases were all linked to equivalent population data also obtained through ONS. 2004 based population projections have been acquired from the Government Actuary's Department website (<http://www.gad.gov.uk>) to facilitate projection of incidence and mortality into the future whilst adjusting for the predicted change in the structure of the Welsh population.

Numbers of cases have been tabulated in 5 year time periods, the first time period being 1974-1978 with five year groupings up to the last time period 1999-2003. The only exception to this being the mortality data for colon cancer for which the first time period included is 1979-1983.

The data has been modelled using age-period-cohort (APC) analysis in the form proposed by Clayton and Schifflers^{1,2} using the statistical package STATA³. The APC analysis fits regression models to the data and describes the incidence rate as a function of age, calendar period and birth cohort. Following the selection of the 'best' model for each site/sex combination, these 'best' models have been used to project future trends. Since the age, calendar period and birth cohort are inherently linked (linearly dependent) the modelling is unable to distinguish between the linear effects of time period and of birth cohort. Consequently the model is parameterised to include a drift parameter, which describes the linear trend not attributable to either period or cohort effects.

Models were considered sequentially with the addition of further terms, and compared with the previous model using a likelihood ratio test. To allow for multiple testing the more complex

model has only been accepted if $p < 0.01$ as opposed to the conventional cut-off value of $p < 0.05$. The null model was that containing just age. The terms added sequentially were then drift (*D*), non-linear period (*P*) or non-linear cohort (*C*), non-linear period *and* non-linear cohort (*PC*), the most complex model being the full APC model with drift (*APCD*). If both non-linear calendar period and non-linear birth cohort, individually, met the criteria for inclusion then the one selected was that with the highest statistical significance.

Each of the ‘best’ models has been used to project future incidence/mortality for the calendar periods 2004-2008, 2009-2013 and 2014-2018. In order to do this it is crucial to include appropriate values for the effects of age and, if required by the model, of calendar period and birth cohort. The age effects from the ‘best’ models have simply been carried into the future models.

Since we are predicting into the future we of course have no information about the effects of the future calendar periods. For our analysis it has been assumed that the effects of time period for these three periods are the same as that of the most recent time period included in the analysis, 1999-2003.

These future calendar time periods also incorporate birth cohorts which have not been included in the modelling process and for which we therefore have no information. It seems logical to assume that the situation for these birth cohorts will be nearest that of the youngest birth cohort included in the analysis (those aged 35-39 in 1999-2003). However this birth cohort is that which contains the fewest number of cases and hence upon which modelling estimates have been based on. Thus for this project the experiences of future birth cohorts are assumed to be the same as those aged 35-49 in 1999-2003.

The drift represents a linear trend by calendar period or birth cohort. It is not possible to say whether the inclusion of this term is valid for future projections; as such we have considered predictions both with and without. The choice over the inclusion or exclusion of the drift term has been influenced by its statistical significance in the model and by examination of the

predicted values with the historical data. Consequently the presented ‘best model’ in the results tables in some cases does not include the drift term.

Presented along with the predictions obtained from the APC modelling are predictions based on the current age specific rates. These are labelled ‘ASR’ in the results tables. The age specific rates for the most recent calendar period, 1999-2003, have been applied to future projected population figures. It should be noted that this method takes into account the changes in population structure but assumes that there will be no deviation from the rates of cancer found in the period 1999-2003 into the future, which of course will not be the case.

Projections of incidence/mortality figures into the future should always be viewed with caution. There are a number of accepted methods of calculation and each, whilst equally valid, will not give the same results. With the projections obtained with the APC modelling assumptions have been made which may not necessarily hold. In any statistical modelling predicted values obtained outside of the range used for the model should be considered carefully.

The predictions are not able to take into account changes which occur outside of the range covered by the past data, such as the effects of new drugs/treatments or environmental issues affecting birth cohorts not included in the statistical analysis.

For this reason we would stress the importance of reviewing these figures in context and alongside other information.

3. RESULTS

3.1 Colon Cancer

3.1.1 Incidence

Table 3-1: Observed and projected figures for colon cancer incidence in Wales

	Male			Female		
	Observed Cases	Best Model	ASR	Observed Cases	Best Model	ASR
1974-1978	1990			2425		
1979-1983	1829			2344		
1984-1988	2124			2545		
1989-1993	2566			2860		
1994-1998	3067			3131		
1999-2003	3232			2968		
2004-2008		3929	3523		3241	3068
2009-2013		4782	3898		3578	3221
2014-2018		5832	4344		4020	3447
	<i>Best model: APCD</i>			<i>Best model: APD</i>		

3.1.2 Mortality

Table 3-2: Observed and projected figures for colon cancer mortality in Wales

	Male			Female		
	Observed Cases	Best Model	ASR	Observed Cases	Best Model	ASR
1974-1978						
1979-1983	1343			1724		
1984-1988	1652			1884		
1989-1993	1731			1926		
1994-1998	1736			1820		
1999-2003	1639			1576		
2004-2008		1723	1796		1532	1636
2009-2013		1833	2002		1505	1718
2014-2018		1966	2242		1503	1832
	<i>Best model: APD</i>			<i>Best model: APD</i>		

3.2 Rectal Cancer

3.2.1 Incidence

Table 3-3: Observed and projected figures for rectal cancer incidence in Wales

	Male			Female		
	Observed Cases	Best Model	ASR	Observed Cases	Best Model	ASR
1974-1978	1532			1159		
1979-1983	1884			1615		
1984-1988	2313			1749		
1989-1993	2092			1482		
1994-1998	2141			1397		
1999-2003	2197			1391		
2004-2008		2336	2380		1324	1445
2009-2013		2502	2615		1276	1521
2014-2018		2661	2875		1248	1622
	<i>Best model: APC</i>			<i>Best model: APD</i>		

3.2.2 Mortality

Table 3-4: Observed and projected figures for rectal cancer mortality in Wales

	Male			Female		
	Observed Cases	Best Model	ASR	Observed Cases	Best Model	ASR
1974-1978	1004			740		
1979-1983	978			741		
1984-1988	1002			735		
1989-1993	941			632		
1994-1998	929			571		
1999-2003	850			570		
2004-2008		875	927		491	592
2009-2013		863	1027		445	623
2014-2018		845	1146		394	663
	<i>Best model: ACD</i>			<i>Best model: AC</i>		

4. CONCLUSIONS

The tables below summarise the findings of this report and highlight the projected values for the number of cases and the number of deaths for both colon and rectal cancer for 2015. The figures obtained using the APC modelling are presented alongside the figures acquired through applying the current age specific rates (ASR) for the final period 1999-2003 to projected populations for comparison. However, note that projecting the current age specific rates may produce spurious projected figures if cancer incidence or mortality trends are decreasing over the entire period since the age-sex population is generally increasing throughout Wales.

4.1 Colon Cancer

		Cases per yr	Deaths per yr
1999-2003	Observed	1240	643
2014-2018	APC modelling	1970	694
	ASR	1558	815

4.2 Rectal Cancer

		Cases per yr	Deaths per yr
1999-2003	Observed	718	284
2014-2018	APC modelling	782	248
	ASR	900	362

4.3 Wales v Scotland

The table below compares the Welsh and Scottish figures for colorectal cancer. Note that the Scottish figures were calculated using colorectal cancer as a whole whereas the figures by Wales were calculated using colon cancer and rectal cancer separately. Also note the different time

periods that the projections were based on and the actual projection period, Wales being 2014-2018 and Scotland for 2010-2014.

WALES		Cases per year	Percentage Change	Deaths per year	Percentage Change
1999-2003	Observed	1958		927	
2014-2018	APC Modelling	2752	+40.6	942	+1.6
2014-2018	ASR	2458	+25.5	1177	+27.0

SCOTLAND		Cases per year	Percentage Change	Deaths per year	Percentage Change
1995-1997	Observed	3401		1682	
2010-2014	APC Modelling	3924	+15.4	1866	+10.9
2010-2014	ASR	3887	+14.9	1920	+14.1

As can be seen, the incidence figures and mortality figures increase for both countries for the period 2010-2014 for both methods. Comparing the two countries, the increases are not similar. This again could be due to colorectal cancer being analysed for Scotland and colon cancer and rectal cancer being analysed separately in Wales. Additionally the Scottish projections use data from 1960 whereas projections for Wales are based on data from 1974.

5. FURTHER WORK

There is substantial demand for high quality projections of incidence and mortality in cancer service planning in Wales; for example in the current work of the Radiotherapy and Chemotherapy Advisory Committee of CSCG and the previous work on the CSCG Strategic Plan. In our previous work we utilised the linear projection methodology for short term projections; in this report we have utilised the APC projection methodology aiming at 10 year

projections. It is clear that this requires considerable input from specialist statistical analysts and it poses a resources capacity issue for WCISU.

We have been strongly influenced by the ground breaking work undertaken by Diane Stockton and Roger Black at the Scottish Cancer Intelligence Unit^{5,6}. As we understand it, similar work in ONS has been put on hold although the linear projection approach is being developed at Northern and Yorkshire Cancer Registry and Information Service (NYCRIS). Similar work is underway in various cancer registries across the world. The New Zealand Cancer Registry has also utilised the APC method amongst others for cancer incidence projections. Bjorn Moller at the Norwegian Centre for Population Based Cancer Research has developed projections for the Nordic countries also based upon APC modelling^{7,8}. The Finnish Cancer Registry has used a different approach based upon Generalised Linear Modelling⁹. Other approaches are being investigated in the USA under the SEER programme and in Italy under the auspices of European Cancer Network. This is a rapidly developing area.

These projections are required to inform planning for cancer services. They are also valuable in the wider context of health service planning as a more general application of epidemiological statistics. If the resources can be found, it is anticipated that this work will be rolled out to other cancer sites in 2006. This projection work is of course only part of the overall project which involves a lot of work from Public Health specialists and senior site specific clinicians

6. ACKNOWLEDGEMENTS

This work has been inspired, in part, by the excellent work carried out by the Scottish Cancer Intelligence Unit^{5,6} in their Cancer Scenarios documents. Welsh Cancer Intelligence & Surveillance Unit wishes to acknowledge the use of the methods developed in Scotland for this report. Discussions with our Scottish colleagues have guided our understanding of their approach but our particular interpretation of this methodology must remain our responsibility.

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