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Comparing cancer mortality and GDP health expenditure in England and Wales with other major developed countries from 1979 to 2006

C Pritchard*[,1] and T Hickish[1,2]

[1]School of Health & Social Care, Bournemouth University, Royal London House, Christchurch Rd, Bournemouth BH1 3 LT, UK; [2]Poole and Royal Bournemouth & Christchurch Hospitals, Dorset, UK

BACKGROUND: Cancer and gross-domestic-product on health expenditure (GDPHE) are critical issues for major developed countries (MDC). Each country's economic input, GDPHE 1980–2005 is contrasted with clinical outputs, cancer mortality rates (CMRs), to compare their efficiency and effectiveness in reducing CMR.

METHODS: World Health Organization's CMR data for baseline years (1979–1981) are compared with 2004–2006 by sex and age. The χ^2-tests are used to determine differences between MDC. Efficiency is analysed by calculating a ratio of average GDPHE to reduced CMR over the period.

RESULTS: *Inputs:* All the countries GDPHE grew substantially. For the United Kingdom this reached 9.3%, which is below the MDC average (10%). *Outputs:* CMR fell substantially (>20%) in six of the ten countries. The male average (15–74 years) CMR in England and Wales had been third highest but by 2004–2006 was sixth, a 31% reduction, which was significantly greater than seven other countries. Initially England and Wales female average CMR was the highest of all countries and is now the second highest. There were significantly greater reductions for the 55–64 and 65–74 years old than in seven and four countries, respectively. GDPHE reduced CMR ratios – the average GDPHE : reduced CMR ratio of England and Wales was 1 : 120, greater than all MDC and double that in four countries.

CONCLUSION: Comparing GDPHE *input* with CMR *output* showed that relatively the NHS achieved more with proportionately less than other MDC.

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Cancer incidence in the major developed countries (MDC) has been rising for decades (Bosetti *et al*, 2005; ONS, 2011) and governments have responded by making major commitments to reduce cancer mortality rates (CMRs) (USNCHS, 2004; D.o.H. 2006a, b) coinciding with substantial increases in gross-domestic-product – on – health expenditure (GDPHE) (US Bureau Statistics, 2009). This raises the issue of the relative effectiveness and efficiency of the different MDC in improving cancer outcomes. An earlier study on survival rates that contrasted England, who had a 'Cancer Plan', with Wales, who did not have a plan until 3 years later, had equivocal outcome results (Rachet *et al*, 2010), but the EUROCARE cancer survival rate studies found that the United Kingdom had done less well than many comparable affluent countries (Berrino *et al*, 2007). Although it was acknowledged that to some extent these studies were too early to examine any effect of the new NHS investment into cancer services (Craft and Pritchard-Jones, 2007), a more recent cancer survival study of six Western countries again found that the United Kingdom did less well than the other nations (Coleman *et al*, 2011). However there are methodological limitations in using survival rates as a measure of effectiveness and there is a need for caution in interpreting country-specific survival rates (Autier and Boniol, 2011; Wegwarth *et al*, 2011); though unequivocally, survival rates are improving in most countries including the United Kingdom (Berrino *et al*, 2007; Rachet *et al*, 2010; Coleman *et al*, 2011).

The current British Government's 'strategy for cancer' (D.o.H. 2011) has been influenced by the United Kingdom's relatively poorer survival outcomes with the Department of Health highlighting the need to improve cancer survival rates, which in part, has been used as justification for the proposed changes to the NHS (Appleby, 2011). This has recently been challenged because the Government appears to have ignored the scale and trajectory of improvements so far attained (Pritchard and Hickish, 2008; Appleby, 2011). The effectiveness and efficiency of health systems is of vital importance (Buxton, 2006; Luce *et al*, 2006) given the GDPHE spent by every MDC, including the proportion for cancer services (USNCHS, 2004; D.o.H. 2006b, 2011). The case for seeking the most efficient and effective health care system is unarguably rational (Cutler *et al*, 2006; Kelley, 2007) but the challenge is how to quantify effectiveness and efficiency, based upon uniform measures over time. Such uniform measures exists for GDPHE

*Correspondence: Professor C Pritchard;
E-mail: cpritchard@bournemouth.ac.uk
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based upon US Bureau of Statistics (2010) and for CMR based upon WHO annual mortality data (WHO, 2008).

This study addresses this challenge by examining changes in CMR in MDC for people under 75 years of age, as reducing cancer deaths in this age group is an objective in the British Government's 'strategy for cancer' (D.o.H. 2011), within the context of a nation's GDPHE. Specifically, the approach used here compares economic *inputs* into health, that is GDPHE, contrasted against clinical *outputs*, that is reduction in CMR which serves as an indicator of effectiveness, and derives a ratio of GDPHE against reduction in CMR as an index of efficiency.

In taking this approach we are mindful of three significant limitations. First, CMRs are influenced by more than just GDPHE as the cause of, and survival from, cancer is a complex genetic–environmental interaction, influenced by a range of socio-economic factors, public health, and social and economic policies (Albano *et al*, 2007; Sloggett *et al*, 2007; Rachet *et al*, 2009; Lyratzopoulus *et al*, 2011). Second, there is a lack of uniform data concerning the proportion of total GDPHE devoted to cancer services. Third, CMR needs to be considered in the context of a nation's cancer incidence and such incidence data is itself neither uniform nor contemporaneous with the CMR data.

There are two null hypotheses that between the end-points of 1979–1981 to 2004–2006 there will be no statistically significant differences in the following:

(1) changes in CMR in England and Wales and the other nine MDC by age and sex, and,
(2) in relation to GDPHE: reduced CMR ratios, the NHS in England and Wales will not be more efficient than any other MDC.

MATERIALS AND METHODS

Eligible countries

Contrasting small with large populations can be problematic therefore only countries with populations of more than 16 million are reviewed and designated as 'MDC', which are Australia, Canada, England and Wales, France, Germany, Italy, Japan, Netherlands, Spain and the United States.

Economic input: (GDPHE)

The international response to dealing with health care is reflected in national GDPHE data, which have been available from 1980 onwards (US Bureau Statistics, 2009). The percentages of GDPHE are analysed, and an average percentage of GDPHE for the 1980–2005 period calculated and the earliest and latest current dates will be shown.

Incidence and fiscal context of changes in CMR

Unlike GDPHE and CMR data, we could find no comparable international uniform annual data for cancer incidence and proportion of GDPHE specifically for cancer services in all the countries under review for matching years but only for the six European countries. Thus incidence and money spent on cancer services are indicative rather than definitive but are used as a surrogate indicator of comparable incidence of cancer and proportional expenditure on cancers services but nothing on Australia, Canada, Japan and the USA.

Fiscal – expenditure on cancer services In respect to the proportion of GDPHE given to cancer services, Wilking *et al* (2009) provide data as a percentage of GDPHE and direct cost per capita based upon 'price parity points' (PPP), that is, cost of comparable items in six European countries, in Euros, but for total per capita expenditure on health presented the data in dollars.

Wilking *et al* (2009) provide data on sales of new cancer drugs between 1993 and 2004, that allows us to calculate a ratio of increase over the period and based upon general population (WHO, 2008) we can calculate expenditure on cancer drugs per capita.

Incidence We found three authoritative sources on incidence although they did not match temporally and their definitions of cancer incidence varied, so comparing incidence rates between the different sources should be considered as an estimate, but definitive when comparing a country's incidence within the same data base.

(1) The OECD issued data incidence on all 10 MDC under review but only for 2002, and for the six European countries for 2008 (OECD, 2010).
(2) Annual data are available from the Office of National Statistics (ONS, 2011) for cases of newly registered neoplasms for England from 1995 to 2006. However, as will be seen, when matched with OECD data for the years 2002 and 2008, OECD is for the whole of the United Kingdom and these rates are very different from those reported by ONS. This may be because of the differing definitions of cancer incidence or actual difference in incidence. There is evidence of an association of cancer incidence and density of population (Pritchard and Evans, 1996) and England of course has a far higher population density than the other home nations. However, the issue is whether the incidence is rising as much as comparing levels between countries. So rates are given for England (ONS, 2011) and for the United Kingdom (OECD, 2010).
(3) Cancer incidence data were available for the USA for 1999 and 2006 (UNCHS, 2010) although these are estimates as three US states were not included.

It is reiterated that fiscal outcomes on cancer services and cancer incidence are an indicative context for considering uniform and consistent data on CMR and GDPHE.

Clinical output (CMR)

Cancer mortality rates are based upon standardised WHO data (2009) drawn from 'all malignant neoplasm' deaths (coded C00 – C97) in each adult age-band for men and women separately and given in rates per million (pm) of population. This enables comparisons to be made between countries' of differing size to produce a percentage or ratio of change. The baseline years are 3-year averages for 1979–1981, compared with the index 3-year average for 2004–2006 and percentages of change of 0.10 (10%) have been considered as clinically substantial (Gladen and Edfeldt, 1988).

Three age bands are compared, adults (15–74 years) based upon the averages of all age bands and people aged 55–64 and 65–74 years for whom improved cancer services are thought most likely to make the more significant impact (Cutler *et al*, 2006; Kelley, 2007) and matches the aims of successive United Kingdom Governments (D.o.H., 2006a, 2011).

As cancer is relatively low in younger adults, the age bands 15–24 and 25–34 are combined to be the 15–34 group.

The 3-year average baseline years 1979–1981 were chosen to match the available GDPHE data (US Bureau of Statistics, 2010), contrasted against the latest 3-year average index years 2004–2006 (WHO, 2008), which allows for comparisons of global mortality categories over different periods (USDHHS, 2005). The German baseline had to be an average of 1980–1982 of the former East and West Germany.

Some MDC latest data ended before 2006, for example, Australia, Italy (2001–2003). To enable a direct comparison with these countries the data for England and Wales for those years are matched against these MDC index years. All countries used the 10th edition of the International Classification of Disease (WHO, 1992).

To provide a more clinical context, the reduction in CMR over the period are translated into numbers of deaths if people had continued to die at the level they did in 1979–1981, rather than the rate found in the index years, based upon each MDC latest 15–74 year population.

Comparing England and Wales *vs* other MDC

The χ^2-tests compare the outcomes between England and Wales and the other MDCs for adult average (15–74) and the 55–64 and 65–74 by age bands by sex and statistical significance is at the <0.05 probability level.

Efficiency: effectiveness ratios

To estimate a degree of efficiency between economic inputs and reduced CMR outputs a ratio of average GDPHE to CMR reductions over the period are calculated. As the focus is upon the country's efficiency the combined female and male CMR are used in the GDPHE : CMR ratio. These ratios provide another area of comparison for England and Wales with the other countries.

RESULTS

Economic inputs; GDPHE

Table 1 gives GDPHE for each MDC for 1980 and 2005 and an average for the period.

Throughout the period the USA had the highest GDPHE, rising from 9.1 to 15.3% whereas the United Kingdom went from 5.6 to 9.3%, rising from being the second lowest to sixth lowest out of the 10 countries, which equated to the second biggest increase in GDPHE over the period only exceeded by the USA. Despite this increase it still remained below the MDC average of 10.0% and it is equal to the third lowest over the whole period, averaging 7.5%.

Clinical outcomes – CMR

Male CMR 1979–2006 the MDC with the current highest 'adult' (15–74) CMR is France at 3607 pm and Spain at 3487 pm, England and Wales at 2869 pm were sixth highest, the lowest CMR was in Australia 2842 pm and Japan 2863 pm.

Six countries had substantial falls (>20%) over the period. England and Wales had been the third highest at 4156 pm, falling to 2869 pm, a 31% reduction.

Cancer mortality rates fell substantially for the 55–64 and 65–74 year olds in six and three countries, respectively, both included England and Wales whose reductions were 35% and 28%, respectively (Table 2).

Table 1 Total percentage of GDPHE by MDC (1980–2005) (MDC ranked by highest average GDPHE)

Country	1980	2005	Average 1980–2005	% Change in 1980–2005
USA	9.1	15.3	12.2	68
Germany	8.7	10.7	9.7	23
France	7.1	11.1	9.1	56
Canada	7.1	9.8	8.5	38
Netherlands	7.5	9.2	8.4	23
Australia	7.0	9.5	8.3	36
Italy	7.0	8.9	8.0	27
UK	5.6	9.3	7.3	66
Japan	6.5	8.0	7.3	23
Spain	5.4	8.2	6.8	52
Total average	7.1	10.0	8.6	41

Abbreviations: GDPHE = gross-domestic-product health expenditure; MDC = major developed countries.

Female CMR 1979–2006 the MDC with the highest current 'adult' CMR is the Netherlands at 2249 pm, followed by England and Wales at 2202 pm, a reduction of 19% from the earlier period when they had the highest rate. The current lowest CMR is Japan at 1404 pm and Spain 1468 pm.

It should be noted that in the three age bands, 35–44, 45–54 and 55–64, England and Wales had the biggest reduction over the period.

England and Wales and five other countries had substantial (>20%) reductions in the 45–54 age band but only the Anglo-Welsh and Japan had substantial falls for the 55–64 age band, whereas only Germany and Japan for the 65–74 year olds (Table 3).

International comparisons Males: Table 4 shows that England and Wales male average CMR fell significantly more than seven other countries, including the USA, over the period. In regard to the 55–64 and 65–74 age bands, Anglo-Welsh male rates fell significantly more than six countries and eight other countries, respectively.

Table 2 All malignancies (in males) (rates per million) during 1979–1981 *vs* 2004–2006 ranked by highest current rates

MDC, years	Average 15–74	15–34	35–44	45–54	55–64	65–74
France, 79–81	4605	112	580	2657	6034	12642
2003–2005	3607	73	389	2144	5037	10390
% change	−22	−35	−33	−19	−17	−18
Spain, 79–81	3317	121	480	1688	4564	9730
2003–2005	3487	70	377	1761	4696	10531
% change	+5	−31	−21	+4	+3	+8
Italy, 79–81	4048	121	541	2282	5940	11358
2001–2003	3429	79	298	1353	4478	10939
% change	−15	−35	−45	−41	−25	−4
Netherlands, 79–81	4406	104	383	1702	5496	14347
2004–2006	3191	70	274	1207	3902	10531
% change	−28	−33	−28	−29	−29	−27
Germany, 79–81	3901	115	442	1940	4980	12027
2004–2006	3037	60	280	1338	4282	9225
% change	−22	−48	−37	−31	−14	−22
England and Wales, 79–81	4156	115	418	1715	5536	12998
2001–2003	3100	72	269	1201	3888	10070
% change	−15	−36	−36	−30	−305	−23
2002–2004	2978	74	262	1134	3750	9572
% change	−30	−37	−37	−34	−32	−25
2003–2005	2903	72	268	1089	3645	9443
% change	−40	−38	−36	−37	−34	−27
2004–2006	2869	72	261	1061	3585	9368
% change	−31	−38	−38	−38	−35	−28
Canada, 79–81	3542	100	390	1677	4949	10595
2002–2004	2974	59	263	1090	3731	9726
% change	−16	−41	−33	−35	−25	−8
USA, 79–81	3690	102	434	1891	5173	10851
2003–2005	2903	68	296	1244	3777	9128
% change	−21	−33	−32	−34	−27	−16
Japan, 79–81	3317	104	432	1602	4298	10150
2004–2006	2863	65	234	1152	3628	9234
% change	−14	−37	−46	−28	−16	−9
Australia, 79–81	3575	107	413	1620	4752	10983
2001–2003	2842	95	283	1039	3458	9333
% change	−21	−11	−31	−36	−27	−15

Abbreviation: MDC = major developed countries.

Table 3 All malignancy deaths (in females) by age in MDC rates per million and percentage of change during 1979 to 2006) (ranked by current highest rate)

Country, years	Average 15–74	15–34	35–44	45–54	55–64	65–74
Netherlands, 1979–1981	2273	97	538	1579	3199	5953
2004–2006	2249	71	441	1449	3233	6031
% change	−1	−27	−18	−8	+1	+1
England and Wales, 1979–1981	2716	117	612	1935	4073	6844
2001–2003	2414	78	423	1374	3279	6915
% change	−11	−33	−21	−29	−19	+1
2002–2004	2359	80[2]	406	1344	3196	6768
% change	−13	−32	−34	−31	−22	−1
2003–2005	2228	75	373	1221	3019	6451
% of change	−18	−36	−39	−37	−26	−6
2004–2006	2202	69	374	1179	3011	6377
% of change	−19	−41	−39	−39	−26	−7
Canada, 1979–1981	2345	91	507	1621	3475	6031
2002–2004	2294	66	415	1286	3209	6496
% change	−2	−28	−18	−21	−8	8
USA, 1979–1981	2328	91	494	1507	3560	5989
2003–2005	2164	65	381	1158	2903	6311
% change	−7	−29	−23	−23	−18	+5
Australia, 1979–1981	2100	95	479	1447	3046	5431
2001–2003	1949	68	375	1096	2615	5593
% change	−7	−28	−28	−24	−14	3
Germany (1980–1982)	2363	107	502	1470	3322	6414
2004–2006	1899	55	340	1180	2787	5131
% change	−20	−49	−32	−20	−16	−20
Italy, 1979–1981	2100	109	525	1373	2922	5569
2001–2003	1815	69	377	1134	2524	4973
% change	−14	−37	−28	−17	−14	−11
France, 1979–1981	1955	100	455	1325	2687	5208
2003–2005	1728	66	402	1221	2385	4566
% change	−12	−34	−12	−8	−11	−12
Spain, 1979–1981	1767	103	440	1571	2328	4391
2003–2005	1468	63	367	1015	1968	3927
% change	−17	−39	−17	−35	−16	−11
Japan, 1979–1981	1830	110	467	1146	2432	4996
2004–2006	1404	58	314	976	1902	3770
% change	−23	−48	−33	−15	−22	−25

Abbreviation: MDC = major developed countries.

Females: England and Wales female average CMR fell significantly more than only three other countries. In respect to the 55–64 and 65–74 age bands Anglo-Welsh female CMR declined significantly more than six and four other countries. CMR in Germany, Italy, Japan and Spain in the 65–74 years age band fell significantly more than in England and Wales over the period.

Efficiency: average GDPHE:reduced CMR ratios Table 5 shows the average GDPHE (1980–2005) against the combined gender reduced CMR. England and Wales had the biggest overall annual reduction of 900 pm, which divided by the 7.5% average GDPHE, gives a ratio of 1:120. The next biggest ratios were in the Netherlands at 1:74 and Germany 1:68.

The Anglo-Welsh GDPHE: CMR ratio was superior to all those MDC with matched but earlier CMR and was more than double that of Canada (1:36), Japan (1:60), Spain (1:9) and the USA (1:39).

Table 4 Comparing England and Wales changed CMR (15–74 years of age) with other MDC from 1979 to 2006 by sex

England and Wales *vs* country	All ages χ^2: *P*-value	55–64 years χ^2: *P*-value	65–74 years χ^2: *P*-value
Australia			
Male	3.3958: n.sig	1.3445: n.sig	**22.82**: **<0.0001**
Female	1.560: n.sig	3.2761: n.sig	0.5565: n.sig
Canada			
Male	**21.04**: **<0.0001**	**12.4848**: **<0.001**	**128.4**: **<0.0001**
Female	**8.5524**: **<0.01**	**22.92**: **<0.0001**	**11.8958** **<0.001**
France			
Male	**12.1578**: **<0.001**	**68.83**: **<0.0001**	**42.48**: **<0.0001**
Female	2.9207: n.sig	**23.75**: **<0.0001**	**7.3656**: **<0.01**
Germany			
Male	**12.3079**: **<0.001**	**90.07**: **<0.0001**	**10.3311**: **<0.005**
Female	0.0438: n.sig	**12.9373**: **<0.001**	35.59: <0.0001
Italy			
Male	**14.6885**: **<0.001**	**6.0512**: **<0.02**	**133.2**: **<0.0001**
Female	0.4325: n.sig	**3.8476**: **<0.05**	22.73: <0.0001
Japan			
Male	**40.29**: **<0.0001**	1.3445: n.sig	**22.827**: **<0.0001**
Female	1.4641: n.sig	2.0929: n.sig	57.94: <0.0001
Netherlands			
Male	2.0362: n.sig	**9.4356**: **<0.01**	0.9591: n.sig
Female	**23.26**: **<0.0001**	**81.67**: **<0.0001**	**11.0023**: **<0.001**
Spain			
Male	**142.9**: **<0.0001**	**228.6**: **<0.0001**	**418.7**: **<0.0001**
Female	0.0778: n.sig	**11.4617**: **<0.001**	3.55239: n.sig
USA			
Male	**11.7845**: **<0.001**	1.3445: n.sig	**22.827**: **<0.0001**
Female	**9.1482**: **<0.01**	**7.5784**: **<0.01**	**19.8499**: **<0.001**

Abbreviations: CMR = cancer mortality ratio; MDC = major developed countries; n.sig = not significant. Significantly better outcome values of England and Wales are given in bold.

Table 5 Reduced male and female CMR (15–74) rates pm during 1979 to 2006) (average GDPHE to reduced deaths ratio (ranked by the biggest ratio GDPHE : deaths))

Country, years to 2001–2006	Reduced CMR pm	No of deaths saved from 1979 to 2006	Average GDPHE	Reduced deaths : GDPHE ratio
England and Wales				
2001–2003	679	27 187	7.1	1 : 96
2002–2004	767	30 710	7.2	1 : 107
2003–2005	870	34 484	7.3	1 : 119
2004–2006	900	36 032	7.5	1 : 120
Germany	664	54 873	9.7	1 : 68
Netherlands	620	10 135	8.4	1 : 74
Japan	440	42 571	7.3	1 : 60
Italy	452	20 068	8.0	1 : 57
France	612	37 332	9.1	1 : 67
Australia	442	8783	8.3	1 : 53
USA	475	140 794	12.2	1 : 39
Canada	310	7556	8.5	1 : 36
Spain	64	2154	6.8	1 : 9

Abbreviations: CMR = cancer mortality ratio; GDPHE = gross-domestic-product on health expenditure; pm = per million.

Table 6 Estimates of incidences of all cancers: source is OECD, but ONS (2011) for England and USNCHS for USA. Ranked by highest current rates (rates per million population)

Country	Total rates
England	
2002	6448
2006	6092
2008	6585
% change	
2002–2008	+2%
USA	
1999	4611
2006	4806
% change	+4%
France	
2002	2895
2008	3080
% change	+6%
Netherlands	
2002	2830
2008	2945
% change	+4%
Germany	
2002	2805
OECD	
2008	2885
% change	+3%
Italy	
2002	2765
2008	2810
% change	+2%
UK	
2002	2740
2008	2749
% change	+2%
Spain	
2002	2435
2008	2485
% change	+2%
Australia	
2002	3120
Canada	
2002	3000
Japan	
2002	2148

Abbreviations: USNCHS = US National Center for Health Statistics; OECD = Organisation for Economic Co-operation and Development.

The England and Wales GDPHE : CMR ratio taken in comparison to that for other MDC suggests a high degree of efficiency.

CMR translated into numbers: in column three of Table 5 each MDC reduced 'adult' (age 15–74) the number of deaths are shown based upon the difference between CMR over the period. In the USA there were annually more than 140 000 fewer deaths, Germany 54 000, Japan 42 000 and 36 000 fewer in England and Wales.

Context incidence: Table 6 provides data on incidence of cancer for England, the United Kingdom and five other European countries and the USA.

The incidence of new cancers in England in 2008 was 6585 per million (pm) and it was a 2% increase over the 2002 figure, however, based upon the OECD the latest UK rate was 2485 pm, slightly lower than the other countries except Spain but also showed a 2% increase over the period. OECD incidence ranges from France at 3080 pm, a 6% rise over the period down to Spain at 2485, overall averaging 2826 pm with one s.d. of 171 pm, France and Spain being more than one s.d.

The USA 2006 rate of 4806 pm was a 4% rise from their 1999 data.

Thus overall, based on all sources of data cancer incidence in these seven countries had risen over the last 6- or 7-year period.

Table 7a Cancer expenditure as the percentage of GDPHE 2007 and cost per capita patient in six countries

Country	CA costs as percentage of GDPHE Euro	Direct costs per cancer per capita Euros	Per capita total expenditure on health PPP, $
Germany	7.2	216	3370
France	6.6	205	3550
Italy	6.4	144	2600
Spain	6.4	141	2450
Netherlands	5.6	170	3400
UK	5.6	132	2750
Average	6.3	168	3020

Abbreviations: CA = cancer; GDPHE=gross-domestic-product on health expenditure; PPP = price parity points. Source Wilking *et al* (2009).

Table 7b Sales of new cancer drugs in Europe in Euros (1000s) during 1993 to 2004 per million population (ranked by the biggest population to cost ratio)

Country	Sales in 1993, Euros (1000s)	Current sales, Euros (1000s)	Ratio of increase	Sales per million population
France	196 020	1 288 844	6.61	21 132
Italy	151 756	904 348	5.95	15 698
Spain	54 781	648 935	11.85	14 953
Germany	216 841	1 191 208	5.49	14 412
Netherlands	34 854	207 824	5.96	12 735
UK	97 710	665 818	6.81	11 053

Source: extrapolated from Wilking (2009).

Expenditure on cancer services The first column in Table 7a is the proportion of GDPHE expended on cancer services in 2007 and shows that Germany spent proportionally most of its GDPHE on cancer services, 7.2%, the average of the six European MDC being 6.3%, with the United Kingdom at 5.6%. However, it must be remembered that the United Kingdom had the biggest second increase of GDPHE over the 1980–2005 period, therefore the 5.6% would be worth more within the context of total UK GDPHE.

The direct costs per capita for cancer reflected the above results as column two shows that Germany spent 216 Euros compared with the United Kingdom at 132 Euros; the average being 168 Euros.

Column three shows expenditure per capita per PPP, in dollars, with France and Germany spending most (>$3370), with an average for the six countries of $3020 and again the United Kingdom being below this average at $2750.

Table 7b shows expenditure on cancer drugs in the six European countries between 1993 and 2004 and again reflects the percentages of GDPHE spent on cancer services. The highest was the French expenditure per population at 21 132 Euros and the United Kingdom was lowest at 11 053 Euros, with the other countries being close to the overall average of 14 997 Euros. However, apart from Spain, the United Kingdom had the biggest proportional increase over the period, its cancer drug bill rising by 6.81%.

DISCUSSION

Limitations

One limitation of this study is the slight difference in index years between England and Wales and Australia, Canada, France, Italy, Spain and the USA. However, all comparative χ^2-tests of reduced CMR and the average GDPHE : reduced CMR ratios of England and Wales were matched with the years of these countries. Moreover, this study concerns the effectiveness and efficiency of cancer services relative to the other MDC and not life expectancy *per se*, which now finds England and Wales exceeding the USA and a number of other MDC (US Bureau Statistics, 2009). There were also constraints due to the unavailability of uniform estimates of incidence of new cancers, with differing sources producing varied rates, although irrespective of source, all the countries incidence has increased over the last few years. There were also limits in exploring the proportional costs of GDPHE going to cancer, to match the consistent CMR data and GDPHE data for all 10 MDC. Consequently the incidence and cancer-specific expenditure were indicative contexts for changes in the CMR.

Despite these limitations this study shows the relative changes in CMR in the context of GDPHE for the 10 MDC over the period and the relative 'success' of these MDC in reducing CMR in relation to incidence and expenditure of health.

Main findings

The hypothesis that there would be no significant differences between England and Wales and the other nine MDC CMR can generally be rejected. For males, the average CMR and for the 54–65 and the 65–74 age bands declined statistically significantly more than most other MDC.

These improvements were less marked for females but there were notable gains for the 55–64 year olds but less so for the 65–74 year olds.

The hypothesis that the NHS in England and Wales would not be more efficient in reducing CMR in the context of its GDPHE over the period is also rejected as the combined England and Wales reduced CMR : GDPHE ratios were superior to all the other countries and double the ratios found in Canada, France, Japan and the USA, suggesting that relatively the NHS did more with proportionally less.

However, from a practice perspective, what do these CMR figures mean in terms of actual numbers of reduced deaths? Transposing the Anglo-Welsh combined reductions in CMR to number of people alive today who would not have been alive 20 years ago, there are 36 000 fewer deaths annually; in Germany the rate was equivalent to a fall of more than 54 000 deaths and in the USA a reduction of more than 140 000 per year, surely an indication of improved services.

It is noteworthy that the improvements in England and Wales and the other countries occurred within a context of a relatively worsening cancer incidence, but relative to other countries England and Wales had proportionately less of general GDPHE going to cancer services, albeit the second biggest increase of the MDC over the last few years. Yet it would appear that it is the treatment modalities and health care systems that has contributed most to the better showing of the NHS as a recent study on USA expenditure on adult cancer survivors have seen very substantial increases (Short *et al*, 2011) but with relatively less good results. Some American researchers (Faden *et al*, 2009) comparing 'expensive cancer drugs' in the USA and the United Kingdom highlighted key differences in patient's access to such drugs concluding that the UK system was fairer and that the 'British system is better structured to deal with decisions about expensive end-of-life cancer drugs', which reflects the findings of the use of cancer drugs in Europe and United Kingdom by Drummond and Mason (2007).

However, there can be no grounds for complacency as, despite public health improvements in regard to smoking, the incidence of new cases of malignancy have increased in all countries reviewed and depending upon baseline year, substantially so (Pritchard and Evans, 1996; OECD, 2010; USNCHS, 2010; ONS, 2011) although these recent results suggest a possible slowing down of the increases.

Nonetheless, with such incidence of newly diagnosed cancers the challenge to services and resources continues in every country.

Nevertheless, many of the people who are still alive today who would not have been 20 or more years ago will have returned to work and continue to contribute to the wider economy, off-setting some of the cost of the NHS (and other health care systems), a feature often forgotten in debates about the 'cost' of the NHS (Pritchard *et al*, 2011).

Paradoxically, in times of economic stringency, 'good news' showing a reduction in mortality might be unwelcome by those managing and running services who might fear the budget will be cut. Rather these data show what can be achieved with increased 'structured' expenditure, as has occurred in England and Wales over the past 5 years (D.o.H., 2006b). There has been controversy concerning the merits of the NHS cancer plans in England and Wales particularly arising from analysis of 1- and 5-year survival data in Wales as compared with England and the timing of the introduction of these plans (Sikora, 2009; Rachet *et al*, 2009; Richards, 2009). This study with its consideration of CMR, GDPHE and assessment of proportion of GDPHE given to cancer in the context of cancer incidence supports these cancer plans. Indeed given the trajectory of CMR reduction in England and the efficiency of the system that has enabled this, any system-wide reform in England, as planned by the British Government, should be mindful of the elements of the system that underlie the improvements to date.

The focus upon CMR and the substantial improvements at first appears at odds with the findings that the cancer survival rates of England and Wales are not as good as many other countries (Berrino *et al*, 2007; Coleman *et al*, 2011). However, the value of this approach in judging a nation's cancer service – the clinical output – is that it also examines CMR within the context of that country's economic input into health care and incidence of new cancers.

We cannot explain the reasons for the discrepancy between the survival and CMR data; this requires country-specific research.

CONCLUSIONS

In respect to England and Wales, however, our analysis adds to other evidence indicating improvements embedded within the health system will, if not disrupted, soon translate into improved survival (Appleby, 2011; Pritchard and Hickish, 2011). The planned reform of the NHS in England, which have been described as 'controversial and risky' (Roland and Rosen, 2011) needs to be considered in light of this evidence. In the assessment of the effectiveness and efficiency of a health service, the GDPHE : reduced CMR ratio compliments survival rate data but for England and Wales, these results show that the NHS is comparatively effective and efficient, delivering sustained improvement in cancer outcomes, which rivals other MDC.

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