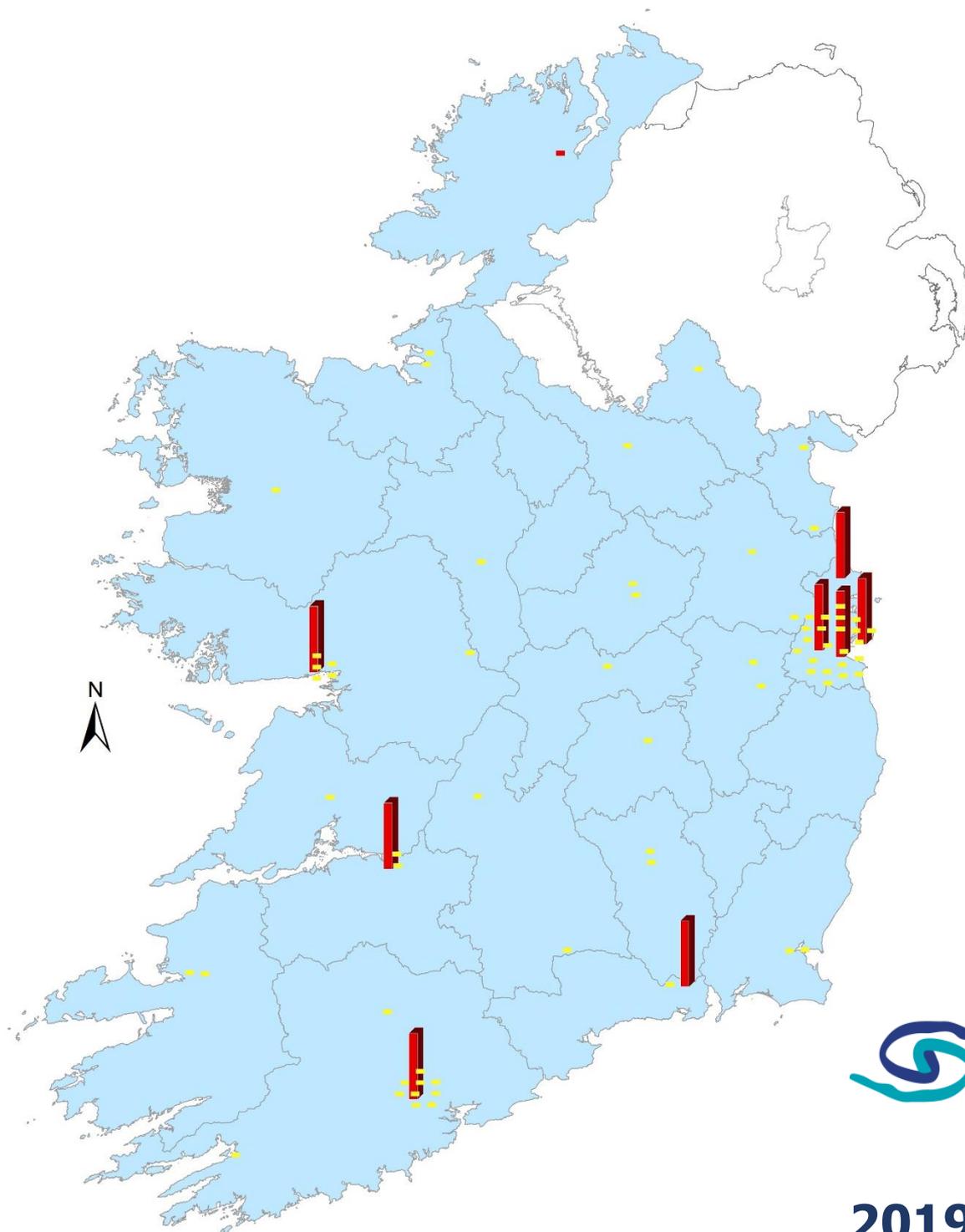


# Cancer care and survival in relation to centralisation of Irish cancer services: an analysis of National Cancer Registry data 1994-2015

## Summary report



Key to cover map: Locations of the eight designated cancer centres are shown as red columns (plus a further 'satellite' site as a red square), other public or private hospitals involved in cancer diagnosis or treatment during 2008-2015 as yellow squares.

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## Cancer care and survival in relation to centralisation of Irish cancer services: an analysis of National Cancer Registry data 1994-2015

### Summary and overview

#### Key points

- In 2007, implementing a recommendation of the National Cancer Strategy for Ireland published in 2006, the Health Service Executive's National Cancer Control Programme (NCCP) initiated a programme of centralisation of publicly-funded cancer services (in particular surgical services) to a smaller number of high-volume, specialist centres with the aim of optimising treatment and improving survival outcomes.
- Of the cancer types included in phase one of NCCP surgical centralisation (*Summary Table 1*) – cancers of the oesophagus, stomach, rectum, pancreas, lung, breast, prostate and brain / central nervous system – the majority show clear evidence of recent centralisation (or existing centralisation), especially relating to surgical treatment.
- Patients in designated centres are generally more likely to receive surgical treatment, radiotherapy, chemotherapy and multi-modality treatment than patients in non-designated public hospitals.
- Treatment/diagnosis in designated centres is, overall, associated with higher survival outcomes than for patients in non-designated public hospitals, even after accounting for differences in age, cancer stage and deprivation status of patients.
- Treatment in private hospitals is also, overall, associated with good survival outcomes and high use of appropriate treatment modalities. The extent to which centralisation may have occurred among private hospitals has not been examined.
- Differences in the appropriateness or quality of treatment, or unmeasured differences in general patient health affecting suitability for treatment, are likely to be contributing to survival differences between hospital categories.
- It should also be emphasised that differences in treatment or survival between categories do not necessarily apply to all individual hospitals within a category, as most private or non-designated hospitals treat very small numbers (while a few hospitals treat more substantial numbers) of cancer patients annually.
- At national scale, the expectation is that centralisation, combined with specialisation and standardisation of diagnostic and treatment services within or across designated cancer centres, has benefited patients. However, centralisation is not the only factor contributing to survival improvements nationally, as more general improvements in treatment across all hospital categories and in early detection have also been underway.
- Further work to more fully explore and explain the findings here is needed, including: factors contributing to survival differences between hospital categories; the relative contributions of centralisation, general improvements in treatment, and improvements in screening/ early detection to cancer survival improvements nationally; updating of analyses as centralisation progresses (including additional cancer types); economic implications of centralisation; referral patterns and treatment quality for patients in non-designated public hospitals.

## Background and methodology

- In 2007, implementing a recommendation of the National Cancer Strategy for Ireland published in 2006 [1], the Health Service Executive's National Cancer Control Programme (NCCP) initiated a programme of centralisation of publicly-funded cancer services (in particular surgical services) to a smaller number of high-volume, specialist centres (*Summary Table 1*) with the aim of optimising treatment and improving survival outcomes.

**Summary Table 1.** NCCP-designated cancer centres by cancer type (excluding radiation oncology centres).

		St. James's <sup>1</sup>	Mater <sup>1</sup>	St. Vincent's <sup>1</sup>	Beaumont <sup>1</sup>	Cork <sup>2</sup>	Galway <sup>2</sup>	Limerick <sup>2</sup>	Waterford <sup>2</sup>	Other <sup>†</sup>
<b>Lung</b>	rapid access clinic	●	●	●	●	●	●	●	●	
	surgery	●	●			●	●			
<b>Breast</b>	symptomatic disease	●	●	●	●	●	●	●	●	Letterkenny (Galway satellite)
	surgery	●	●	●	●	●	●	●	●	Letterkenny
<b>Prostate</b>	rapid access clinic	●	●	●	●	●	●	●	●	
	surgery	●	●	●	●	●	●			
<b>Upper GI</b>	surgery	●			●	●	●			
<b>Pancreas</b>	surgery			●		●				
<b>Rectal</b>	surgery	●	●	●	●	●	●	●	●	Letterkenny
<b>Neuro-oncology</b>					●	●				

● Designated centre. <sup>1</sup>Dublin. <sup>2</sup>Cork, Galway, Limerick and Waterford University Hospitals.  
<sup>†</sup>Letterkenny Hospital is a designated satellite of Galway University Hospital

- This report analyses National Cancer Registry data for the main cancer types included in phase one of the surgical centralisation programme, to assess patterns and trends of treatment and survival, by hospital category and nationally, in relation to centralisation (including contextual data from 1994 onwards).
- Analyses presented in this report cover 201,000 individual invasive cancers (or any invasive or non-invasive tumours of the central nervous system) diagnosed in 196,000 individual patients during the years 1994 to 2015. The cancer sites included are those initially targeted by the NCCP for centralisation of services: oesophagus, stomach, rectum, pancreas, lung, breast, prostate and brain/central nervous system. Invasive cases included here represent just over half (54%) of all invasive cancers (other than non-melanoma skin cancer) diagnosed in Ireland during 1994-2015.
- Analyses are presented for designated cancer centres in comparison with other public hospitals and with private hospitals, categorised on the basis where a patient first had their surgery or tissue-based diagnosis, if applicable (prioritising surgery over biopsy over other treatments or consultations). Analyses relate to the eight cancer centres established in 2008 (St James's, Mater, St Vincent's and Beaumont University Hospitals, Dublin, and Cork, Galway, Limerick and Waterford University Hospitals) and further examine the subspecialisation of cancer surgery outlined in the first phase of NCCP surgical centralisation. Four surgical centres have been designated for upper gastrointestinal cancers, two for pancreatic cancer, eight (plus one satellite) for rectal and breast cancers, six for prostate cancer, and two neuro-oncology centres for

brain / central nervous system tumours (*Summary Table 1*). Patients assigned to centres or to other public hospitals for analysis purposes here include a mix of publicly-funded and privately-insured patients.

- Descriptive statistics are presented on proportions of patients treated or seen in the three hospital categories, and proportions of patients in each hospital category receiving surgery, radiotherapy, chemotherapy or hormone therapy, annually and by broader diagnosis period (1994-2000, 2001-2007 and 2008-2015). Joinpoint modelling is used for formal assessment of trends in distribution of cases and in proportions receiving each treatment modality.
- Cause-specific survival of patients is compared between diagnosis periods and between hospital types, both as descriptive statistics on five-year survival and (for hospital comparisons) as models adjusted for age, sex, stage and an area-based measure of deprivation. The Pobal HP index of deprivation for 2006 [2], at Electoral District scale, is used, but re-expressed as population quintiles (i.e. five categories each covering 20% of the Irish 2006 population).
- Findings are presented as averages based on combined data for all hospitals within a given category, for a given cancer, and do not necessarily apply to all individual hospitals within a category. Within the private and non-designated public hospital categories, most hospitals treat very small numbers of cancer patients while a limited number treat more substantial numbers, which is likely to influence outcomes.
- This report focuses on centralisation activity up to 2014/2015, and it is anticipated that patterns will have further changed more recently and will further change once final-phase implementation of centralisation has taken place.

### ***Patterns of centralisation***

- For the majority of cancer types examined, there was clear evidence of recent centralisation of services (2008 onwards), especially relating to surgical treatment (*Summary Table 2 & Figure 1*).
- Recent centralisation (assessed from proportions of public-hospital patients involved and degree of change compared with the pre-2008 period) appears to have been most marked for breast cancer patients and for surgical pancreatic, rectal, stomach and lung cancer patients.
- Although evidence of recent centralisation was weaker for oesophageal and prostate cancers, high proportions of cases (especially surgical cases) were nevertheless treated in designated centres in the most recent years.
- For brain and other central nervous system (CNS) tumours, treatment was already highly centralised, and modest recent decreases in the proportions of surgical patients treated in the two neuro-oncology centres mainly involve children treated by the Department of Paediatric Neurosurgery of Temple Street Children's University Hospital (at Temple Street or at Our Lady's Hospital for Sick Children, Crumlin) and small numbers of less complex neurosurgical procedures at non-centres.
- Increases in proportion of patients treated in private hospitals was also seen over time for most cancers.
- This report focuses on centralisation activity up to 2014/2015, and patterns are likely to have further changed in the interim and to further change once final-phase implementation of centralisation occurs.

**Summary Table 2.** Patterns of centralisation by broad diagnosis period: percentages of 2008-2015 cases first treated or diagnosed in designated cancer centres, and change in relative terms compared with 2001-2007.

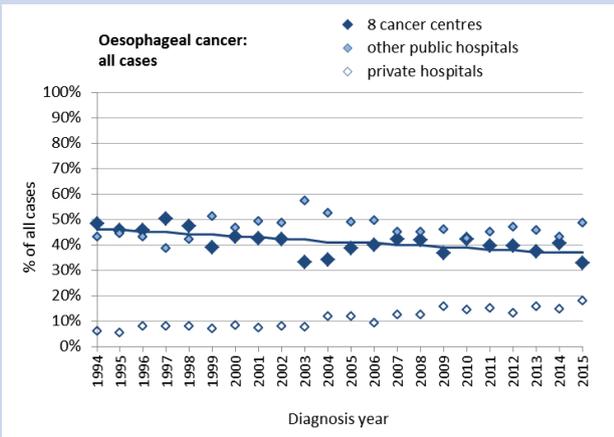
Cancer	number of centres	% of cases first treated or diagnosed in centres				% of public-hospital cases first treated or diagnosed in centres			
		all cases		surgical cases		all cases		surgical cases	
Oesophagus	8	39%	=			46%	+		
	4 surgical	28%	=	<b>63%</b>	++	33%	+	<b>68%</b>	++
Stomach	8	43%	++			<b>50%</b>	++		
	4 surgical	32%	++	<b>54%</b>	++++	37%	++	<b>59%</b>	++++
Rectal	8+1 surgical	47%	+++	<b>52%</b>	+++	<b>58%</b>	+++	<b>63%</b>	++++
Pancreatic	8	44%	+			<b>53%</b>	++		
	2 surgical	16%	++++	44%	+++++	19%	++++	<b>61%</b>	+++++
Lung	8 rapid access	<b>58%</b>	++			<b>64%</b>	++		
	4 surgical	39%	+++	<b>80%</b>	+++	43%	+++	<b>90%</b>	+++
Breast	8+1	<b>70%</b>	++++	<b>68%</b>	++++	<b>92%</b>	++++	<b>92%</b>	++++
Prostate	8 rapid access	42%	++			<b>63%</b>	+++		
	6 surgical	42%	+++	31%	--	<b>62%</b>	+++	<b>60%</b>	++
Brain/CNS (malignant)	8	<b>80%</b>	+			<b>85%</b>	+		
	2 neuro-oncology	<b>72%</b>	+	<b>91%</b>	-	<b>77%</b>	+	<b>96%</b>	-
Brain/CNS (benign/uncertain)	8	<b>74%</b>	--			<b>78%</b>	--		
	2 neuro-oncology	<b>65%</b>	--	<b>94%</b>	-	<b>69%</b>	--	<b>96%</b>	-

\*For general cancer services, 8 centres have been designated, but further details vary by cancer type: 4 specific surgical centres have been designated for upper gastrointestinal cancers (oesophagus and stomach); 8 surgical centres (+ 1 satellite) for rectal cancer; 8 centres as rapid access clinics and 4 surgical centres for lung cancer; 8 centres (+ 1 satellite) as both rapid access clinics and surgical centres for breast cancer; 8 centres as rapid access clinics and 6 as surgical centres for prostate cancer; and 2 neuro-oncology centres for brain/CNS tumours.

“+” <10%, “++” 10-24%, “+++” 25-49%, “++++” 50-99%, “+++++” ≥100% relative increase in proportion of cases treated in centres compared with 2001-2007 diagnosis period. Similarly, minus signs indicate same scale but for relative decreases. “=” no change.

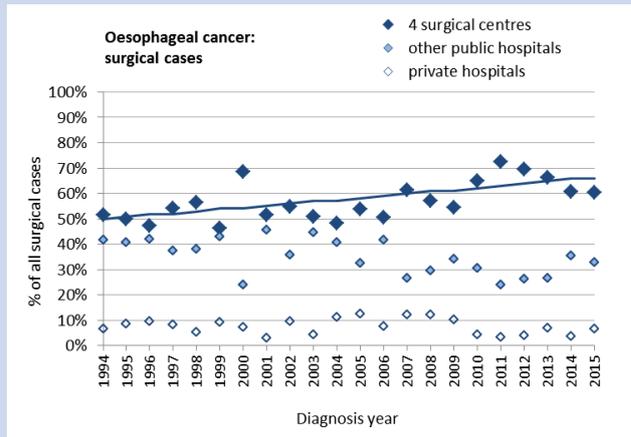
Summary Figure 1 Trends in proportion of cases first treated in HSE cancer centres

**All cases – main cancer centres**  
(by hospital of first surgery > biopsy > other treatment)

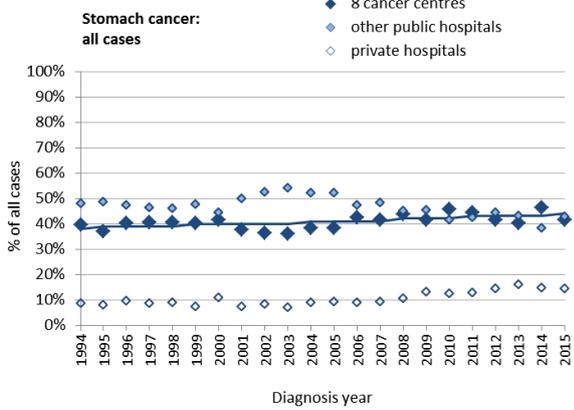


8 centres <sup>1</sup>	Period	APC <sup>5</sup>	95% CI	Trend
	1994-2015	-1.1%	-1.7%, -0.6%	↓

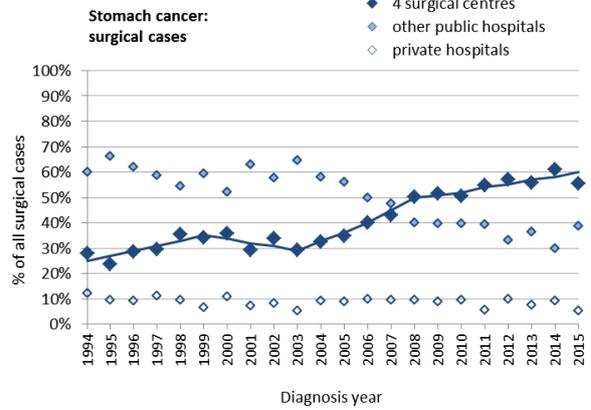
**Surgical cases – designated surgical centres**  
(by hospital of first surgery)



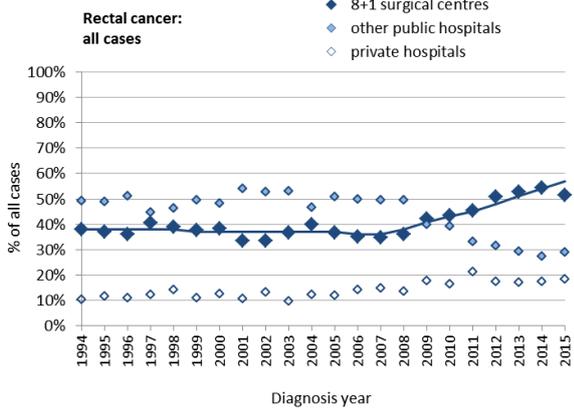
4 surgical centres <sup>3</sup>	Period	APC <sup>5</sup>	95% CI	Trend
	1994-2015	+1.4%	+0.6%, +2.1%	↑



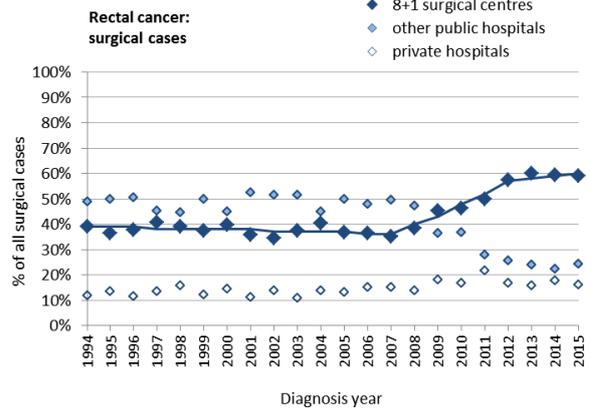
8 centres <sup>1</sup>	Period	APC	95% CI	Trend
	1994-2015	+0.6%	+0.2%, +1.0%	↑



4 surgical centres <sup>3</sup>	Period	APC	95% CI	Trend
	1994-1999	+6.9%	+0.9%, +13%	↑
	1999-2003	-4.6%	-16%, +8.9%	=
	2003-2008	+11.1%	+3.5%, +19%	↑
	2008-2015	+2.7%	+0.5%, +4.9%	↑



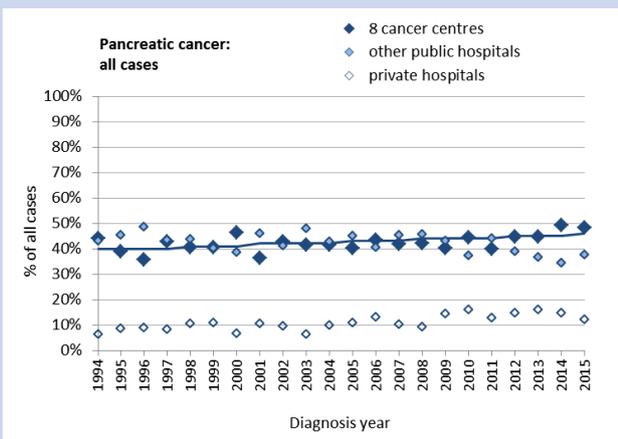
8+1 centres <sup>2</sup>	Period	APC	95% CI	Trend
	1994-2007	-0.4%	-1.4%, +0.7%	=
	2007-2015	+5.7%	+4.0%, +7.5%	↑



8+1 surgical centres <sup>2</sup>	Period	APC	95% CI	Trend
	1994-2007	-0.6%	-1.3%, +0.2%	=
	2007-2012	+9.5%	+5.5%, +14%	↑
	2012-2015	+1.7%	-2.6%, +6.3%	=

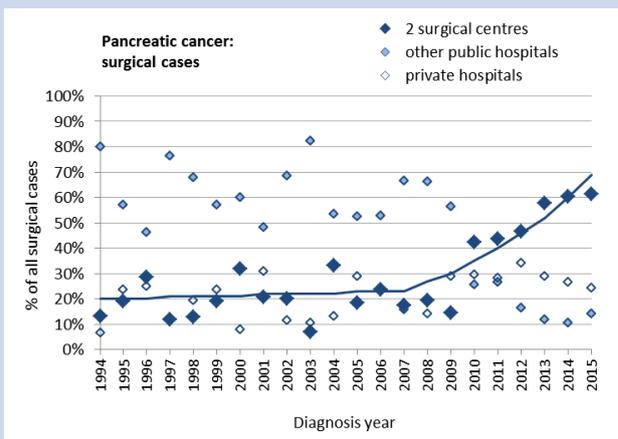
**Summary Figure 1 Trends in proportion of cases first treated in HSE cancer centres**

**All cases – main cancer centres  
(by hospital of first surgery > biopsy > other treatment)**

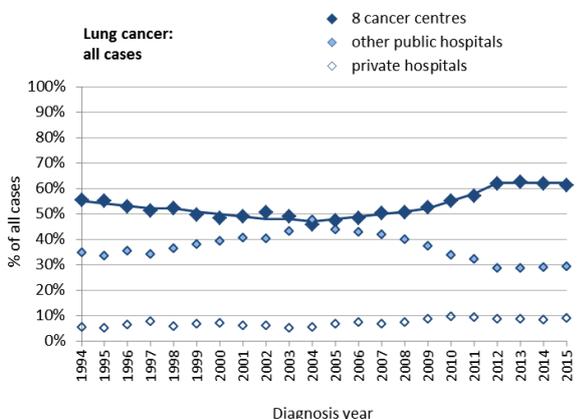


Period	APC <sup>5</sup>	95% CI	Trend
8 centres <sup>1</sup> 1994-2015	<b>+0.7%</b>	+0.2%,+1.2%	↑

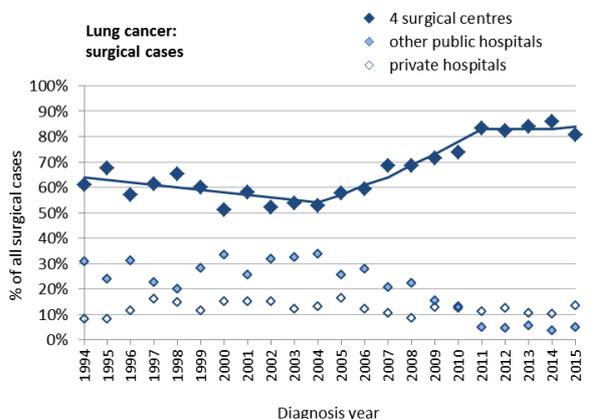
**Surgical cases – designated surgical centres  
(by hospital of first surgery)**



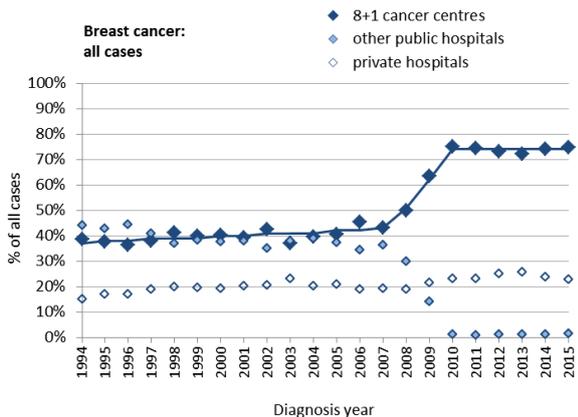
Period	APC <sup>5</sup>	95% CI	Trend
2 surgical centres <sup>3</sup> 1994-2007	+1.2%	-5.2%,+8.1%	=
2007-2015	<b>+14.6%</b>	+8.2%,+21%	↑



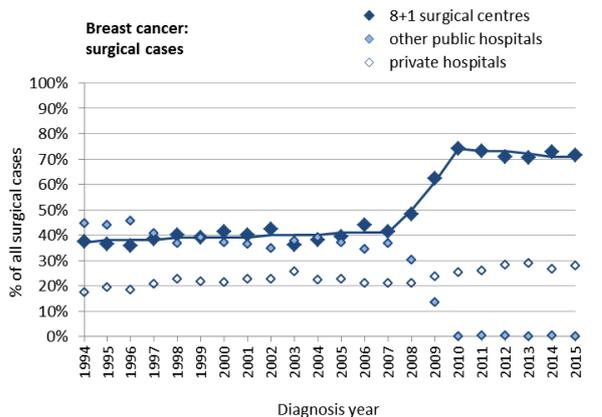
Period	APC	95% CI	Trend
8 centres <sup>1</sup> 1994-2004	<b>-1.6%</b>	-2.1%,-1.1%	↓
2004-2009	<b>+2.1%</b>	+0.1,+4.2%	↑
2009-2012	<b>+5.9%</b>	+0.6,+11%	↑
2012-2015	+0.1%	-2.1%,-2.3%	=



Period	APC	95% CI	Trend
4 surgical centres <sup>3</sup> 1994-2004	<b>-1.8%</b>	-3.4%,-0.3%	↓
2004-2011	<b>+6.4%</b>	+3.8%,+9.0%	↑
2011-2015	+0.4%	-2.1%,+2.9%	=



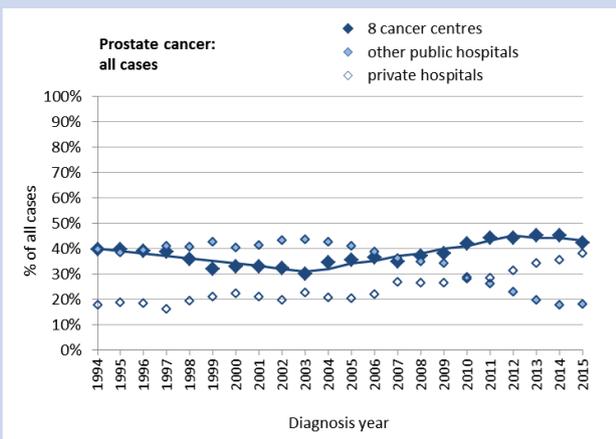
Period	APC	95% CI	Trend
8+1 centres <sup>2</sup> 1994-2007	<b>+1.0%</b>	+0.2%,+1.9%	↑
2007-2010	<b>+20%</b>	+9.6%,+32%	↑
2010-2015	-0.2%	-1.6%,+1.1%	=



Period	APC	95% CI	Trend
8+1 surgical centres <sup>2</sup> 1994-2007	+0.8%	-0.1%,+1.7%	=
2007-2010	<b>+21%</b>	+9.5%,+34%	↑
2010-2015	-0.7%	-2.2%,+0.8%	=

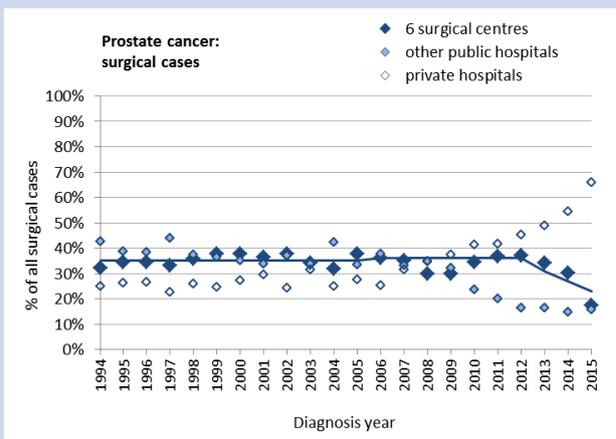
**Summary Figure 1 Trends in proportion of cases first treated in HSE cancer centres**

**All cases – main cancer centres  
(by hospital of first surgery > biopsy > other treatment)**

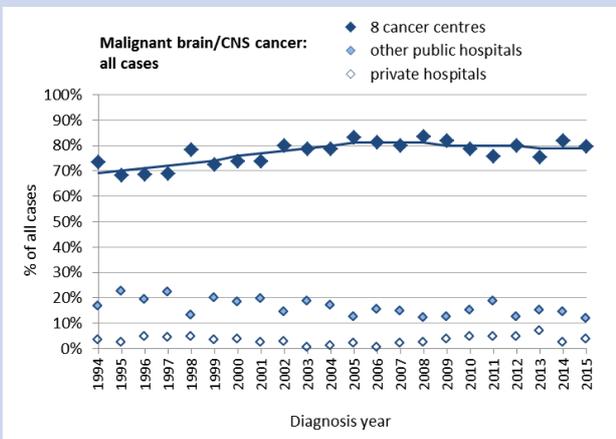


	Period	APC <sup>5</sup>	95% CI	Trend
8 centres <sup>1</sup>	1994-2003	-2.8%	-4.2%,-1.4%	↓
	2003-2012	+4.1%	+2.9%,+5.3%	↑
	2012-2015	-1.0%	-5.5%,+3.6%	=

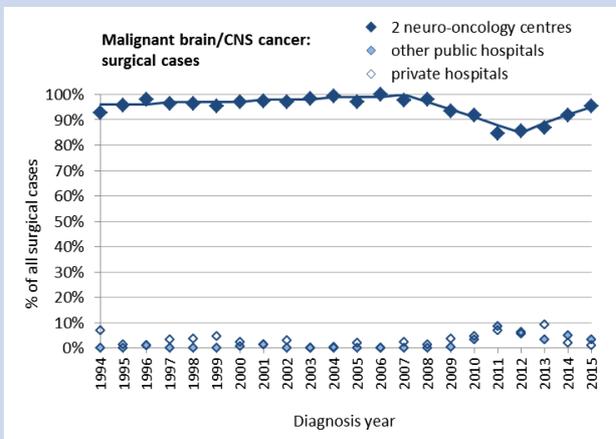
**Surgical cases – designated surgical centres  
(by hospital of first surgery)**



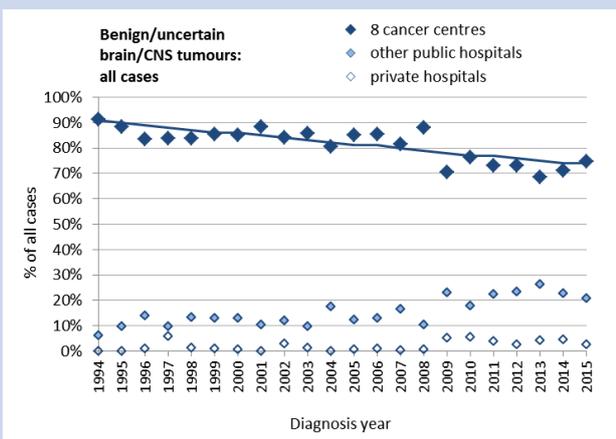
	Period	APC <sup>5</sup>	95% CI	Trend
6 surgical centres <sup>3</sup>	1994-2012	+0.2%	-0.6%,+1.0%	=
	2012-2015	-13.9%	-25%,-1.2%	↓



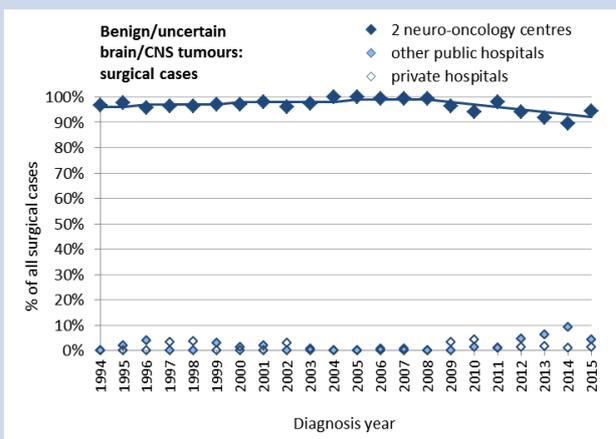
	Period	APC	95% CI	Trend
8 centres <sup>1</sup>	1994-2005	+1.5%	+0.7%,+2.3%	↑
	2005-2015	-0.3%	-1.0%,+0.4%	=



	Period	APC <sup>2</sup>	95% CI	Trend
2 centres <sup>4</sup>	1994-2007	+0.3%	+0.1%,+0.5%	↑
	2007-2012	-3.0%	-4.6%,-1.4%	↓
	2012-2015	+3.6%	+0.9%,+6.4%	↑



	Period	APC	95% CI	Trend
8 centres <sup>1</sup>	1994-2015	-1.0%	-1.4%,-0.6%	↓



	Period	APC <sup>4</sup>	95% CI	Trend
2 centres <sup>1</sup>	1994-2008	+0.2%	0.0%,+0.4%	↑
	2008-2015	-1.1%	-1.8%,-0.5%	↓

<sup>1</sup> 8 centres designated for a range of cancers, and as lung and prostate cancer rapid access clinics, but not specifically for all cancer types.

<sup>2</sup> 8 centres (+ Letterkenny General Hospital satellite to Galway University Hospital) designated for rectal & breast cancer surgery and for symptomatic breast disease.

<sup>3</sup> Centres designated for site-specific surgery for these cancers. <sup>4</sup> Neuro-oncology centres designated for brain / CNS tumours.

Note: In surgical/neuro-oncology centre graphs for sites other than rectum and breast, other cancer centres are included in the “other public hospital” category.

<sup>5</sup> APC = estimated annual % change (relative) across the period specified assessed by Joinpoint analysis [3, 4]: significant increase (↑), decrease (↓) or no significant change (=).

### Variation of patient age, deprivation status and cancer stage by hospital category

- Patients seen or treated in the cancer centres during 2008-2014 were younger on average than those in other public hospitals, generally by 1-4 years (comparing median ages) but by 8 years for brain/CNS cancers and by 14 years for benign/uncertain brain/CNS tumours. This may in part reflect differences in referral patterns by age. Comparisons between the centres and private hospitals were less consistent (patients in the centres were slightly younger for oesophageal, stomach and stomach cancer and for brain/CNS tumours, slightly older for rectal, pancreatic and breast cancer, and the same age for prostate cancer).
- Patients treated or diagnosed in cancer centres tended to include a higher proportion of earlier-stage cases than other public hospitals; differences between the cancer centres and private hospitals varied by cancer type.
- A substantially higher proportion of patients in private hospitals (25-38% depending on cancer type) were from the least deprived population quintile than in the cancer centres (14-21%), and the proportion was lowest in other public hospitals (8-14%); while the proportion of patients from the most deprived population quintile was lower for private hospitals (8-13%) than for the cancer centres (20-31%) or other public hospitals (23-34%).

### Variation of treatment by hospital category

**Summary Table 3.** Treatment comparisons: percentages of 2008-2014 cases in each hospital category who received surgery, radiotherapy, chemotherapy or any tumour-directed therapy within a year after diagnosis.

Ce = designated centre, OP = other public, Pr = private.

**Bold** = hospital categories with the highest proportion of patients receiving treatment

Cancer	Number of centres	Surgery			Radiotherapy			Chemotherapy			Any treatment		
		Ce	OP	Pr	Ce	OP	Pr	Ce	OP	Pr	Ce	OP	Pr
Oesophagus	8	<b>39%</b>	15%	11%	49%	47%	<b>57%</b>	45%	43%	<b>60%</b>	77%	65%	<b>78%</b>
	4 surgical	<b>54%</b>	13%	11%	50%	47%	<b>57%</b>	51%	41%	<b>60%</b>	<b>84%</b>	64%	78%
Stomach	8	<b>55%</b>	27%	26%	<b>19%</b>	14%	17%	43%	36%	<b>55%</b>	<b>74%</b>	56%	71%
	4 surgical	66%	27%	26%	<b>22%</b>	13%	17%	48%	34%	<b>55%</b>	<b>83%</b>	55%	71%
Rectal	8+1 surgical	<b>80%</b>	64%	72%	<b>50%</b>	37%	38%	54%	49%	<b>55%</b>	90%	84%	<b>91%</b>
Pancreatic	8	18%	6%	<b>29%</b>	13%	7%	<b>17%</b>	35%	32%	<b>52%</b>	46%	35%	<b>65%</b>
	2 surgical	<b>41%</b>	6%	29%	<b>17%</b>	9%	<b>17%</b>	39%	32%	<b>52%</b>	61%	37%	<b>65%</b>
Lung	8 rapid access	<b>28%</b>	1%	24%	40%	38%	<b>44%</b>	35%	31%	<b>44%</b>	73%	50%	<b>78%</b>
	4 surgical	<b>38%</b>	3%	24%	37%	42%	<b>44%</b>	34%	33%	<b>44%</b>	<b>78%</b>	55%	<b>78%</b>
Breast	8+1	83%	77%	<b>95%</b>	68%	71%	<b>79%</b>	47%	40%	<b>52%</b>	97%	90%	<b>98%</b>
Prostate	8 rapid access	22%	21%	<b>39%</b>	<b>45%</b>	44%	38%	-	-	-	76%	<b>78%</b>	76%
	6 surgical	21%	22%	<b>39%</b>	<b>45%</b>	43%	38%	-	-	-	75%	<b>78%</b>	76%
Brain/CNS (malignant)	8	<b>56%</b>	12%	52%	<b>65%</b>	29%	59%	28%	36%	<b>45%</b>	<b>82%</b>	42%	77%
	2 neuro-oncology	<b>56%</b>	12%	52%	<b>69%</b>	26%	59%	41%	20%	<b>45%</b>	<b>88%</b>	35%	77%
Brain/CNS (benign/uncertain)	8	<b>68%</b>	9%	25%	6%	1%	<b>33%</b>	-	-	-	<b>71%</b>	13%	55%
	2 neuro-oncology	<b>68%</b>	9%	25%	7%	2%	<b>33%</b>	-	-	-	<b>79%</b>	10%	55%

Hormonal data (breast and prostate cancer) are not plotted separately; chemotherapy data are not shown for prostate cancer and benign/uncertain brain/CNS tumours (<2% of cases received chemotherapy as primary treatment).

- In general, the proportions of patients receiving different treatment modalities (surgery, radiotherapy, chemotherapy, multimodal treatment or overall treatment) increased over time, both for patients in what are now designated centres and overall.
- Across most cancers and treatment modalities examined, patients in designated centres were generally more likely to receive treatment compared with patients in other public hospitals, the main exceptions being prostate cancer and, pre-2008, breast cancer. However, cautious interpretation is needed as patients considered better candidates for treatment may be more likely to be referred to centres.
- Comparisons between private hospitals and the cancer centres differed by cancer type and treatment modality, except for higher use of chemotherapy, on average, by private hospitals.

### Variation of survival by hospital category

**Summary Table 4.** Summary of cause-specific survival of cancer patients diagnosed 2008-2014, by category of hospital where first treated or diagnosed. Ce = designated centre, OP = other public, Pr = private. See *Summary Figure 3* for further details.

Cancer	Number of centres	<sup>1</sup> 5-year survival 2008-2014			<sup>2</sup> Comparison with 2001-2007			<sup>3</sup> Adjusted HR relative to centre (2008-2014 cases)			P-value for comparison with centre		
		Ce	OP	Pr	Ce	OP	Pr	Ce	OP	Pr	Ce	OP	Pr
Oesophagus	8	<b>28%</b>	16%	19%	↑	↑	↑	1.00	<b>1.28</b>	0.91	-	***	ns
	4 surgical	<b>36%</b>	15%	19%	↑	↑	↑	1.00	<b>1.53</b>	1.07	-	***	ns
Stomach	8	<b>32%</b>	24%	22%	↑	↑	↑	1.00	<b>1.23</b>	1.12	-	***	ns
	4 surgical	<b>36%</b>	23%	22%	↑	↑	↑	1.00	<b>1.44</b>	<b>1.30</b>	-	***	**
Rectal	8+1 surgical	63%	52%	<b>65%</b>	↑	↑	↑	1.00	<b>1.23</b>	<b>0.81</b>	-	***	**
Pancreatic	8	10%	6%	<b>11%</b>	↑	↑	↑	1.00	<b>1.11</b>	0.90	-	*	ns
	2 surgical	<b>19%</b>	6%	11%	↑	↑	↑	1.00	<b>1.29</b>	1.06	-	***	ns
Lung	8 rapid access	<b>23%</b>	5%	<b>23%</b>	↑	↑	↑	1.00	<b>1.36</b>	<b>0.89</b>	-	***	**
	4 surgical	<b>29%</b>	7%	23%	↑	↑	↑	1.00	<b>1.44</b>	1.00	-	***	ns
Breast	8+1	85%	81%	<b>93%</b>	↑	↑	↑	1.00	<b>1.23</b>	<b>0.68</b>	-	**	***
Prostate	8 rapid access	91%	88%	<b>95%</b>	↑	↑	↑	1.00	<b>1.31</b>	<b>0.73</b>	-	***	***
	6 surgical	91%	87%	<b>95%</b>	↑	↑	↑	1.00	<b>1.32</b>	<b>0.73</b>	-	***	***
Brain/CNS (malignant)	8	<b>28%</b>	12%	19%	↑	↑	↑	1.00	<b>1.45</b>	1.06	-	***	ns
	2 neuro-oncology	<b>28%</b>	18%	19%	↑	↓	↑	1.00	<b>1.20</b>	1.06	-	*	ns
Brain/CNS (benign/uncertain)	8	<b>96%</b>	84%	93%	↑	↑	↑	1.00	<b>1.92</b>	1.93	-	*	ns
	2 neuro-oncology	<b>97%</b>	86%	93%	↑	↑	↑	1.00	<b>2.19</b>	2.21	-	**	ns

<sup>1</sup>Crude five-year cause-specific survival (not adjusted for age or other factors) – see later columns for adjusted comparisons between hospital types.

<sup>2</sup>Statistically significant improvement ↑ in survival compared with 2001-2007 (↑ non-significant improvement, ↓ non-significant reduction), adjusted for age, sex (except prostate cancer) and stage (except brain/CNS tumours).

<sup>3</sup>Hazard ratio adjusted for patient age, sex, stage and deprivation quintile: HR >1 indicates higher mortality (lower survival), HR <1 lower mortality (higher survival) relative to designated centres (reference level HR = 1.00).

\*P<0.05 \*\* P<0.01 \*\*\*P<0.001 for comparison between hospitals (ns = not significant P>0.05)

- Cause-specific survival of patients improved over time, both nationally and within most hospital categories, for the majority of the cancers and other tumours analysed (*Summary Table 4 & Figure 2*).
- For all cancer/tumour types examined, patients first treated or diagnosed in designated cancer centres had higher survival, overall, than those seen in other public hospitals, even after adjustment for patient age, sex, stage and deprivation. However, as with treatment comparisons, cautious interpretation is needed as this variation could, in part, reflect different referral patterns for patients considered better candidates for treatment. In addition, survival of patients in some non-designated public hospitals may also be high.
- Survival variation between designated centres and private hospitals depended on the cancer or tumour type involved. For rectal, breast and prostate cancers survival of patients in the private hospitals was on average significantly better than in the surgical centres for these cancers, but for stomach cancer, survival of patients in the private hospitals averaged significantly poorer than in the surgical centres.
- Statistical models indicated that stage differences helped explain substantial proportions of the differences seen in survival, while differences in average deprivation status of patients appeared to have a smaller influence. Substantial survival differences between hospitals still remain after adjustment for stage, deprivation, age and sex, suggesting that differences in the appropriateness or quality of treatment, or unmeasured differences in general patient health affecting suitability for treatment, are likely to be contributing to survival differences between hospital categories.

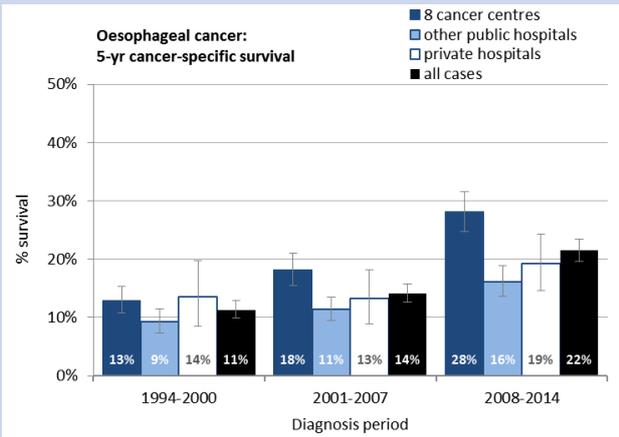
### **Further work**

- More work is needed to explore the reasons for survival differences between patients in hospitals. This might require collation of comparable data on other health conditions (comorbidities) and on general health of patients (e.g. functional status) across hospital categories.
- Analyses specifically attempting to quantify and apportion contributions of different factors (including centralisation, treatment advances and population-based screening) to ongoing survival improvements among Irish cancer patients would be useful, but there are significant methodological challenges.
- Centralisation of services for the cancers included in this report began earlier for some cancers (earliest, from, 2007, for breast cancer) than for others (notably oesophageal cancer), and updated analyses once several further years have elapsed might be more informative regarding the extent to which centralisation has been achieved for the full range of cancers involved.
- Further work is needed to characterise more fully the group of public-hospital cancer patients who are not treated within the designated centres, to assess the factors influencing referral or non-referral of public patients to the cancer centres, and to monitor the quality and appropriateness of treatment (including palliative care) for patients not referred. Also, the economic implications of centralisation should be assessed.
- The analyses presented here could be replicated for additional cancers for which centralisation of services may be under consideration, or for cancer types not currently being considered for centralisation.

Summary Figure 2 Five-year cause-specific survival (by hospital category and period of diagnosis)

**Main cancer centres**

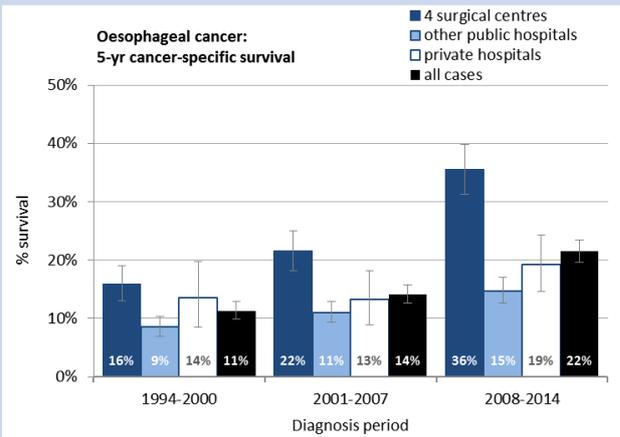
(by hospital of first surgery > biopsy > other treatment)



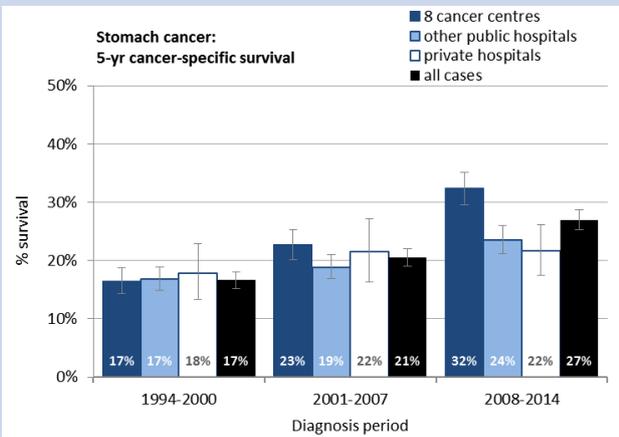
2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8 centres <sup>1</sup>	1.00	-	-
	Other public	<b>1.28</b>	1.13-1.44	<0.001
	Private	0.91	0.77-1.08	0.281

**Designated surgical centres**

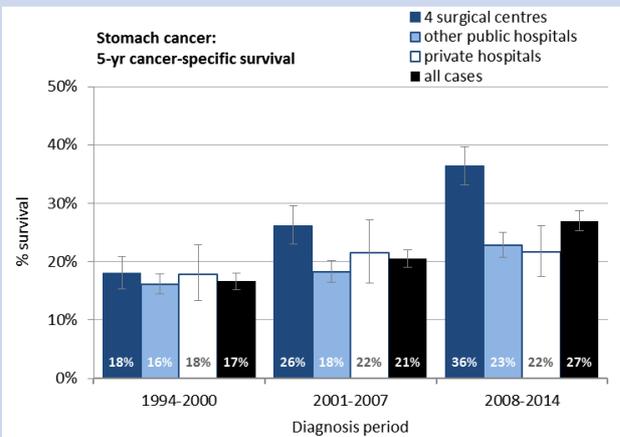
(by hospital of first surgery)



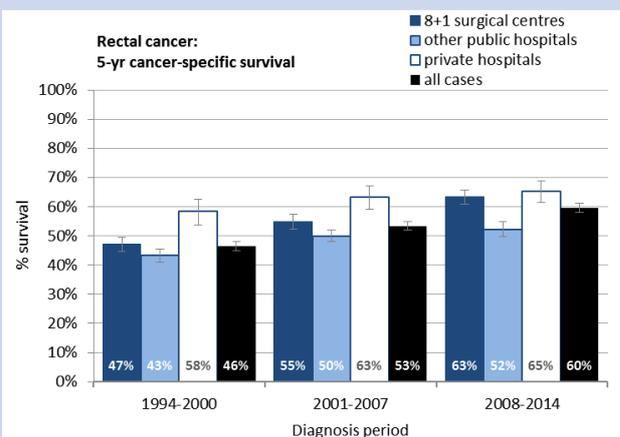
2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>5</sup>	95% CI	P
	4 centres <sup>4</sup>	1.00	-	-
	Other public	<b>1.53</b>	1.34-1.76	<0.001
	Private	1.07	0.89-1.29	0.678



2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8 centres <sup>1</sup>	1.00	-	-
	Other public	<b>1.23</b>	1.10-1.36	<0.001
	Private	1.12	0.99-1.33	0.068



2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	4 centres <sup>3</sup>	1.00	-	-
	Other public	<b>1.44</b>	1.29-1.61	<0.001
	Private	<b>1.30</b>	1.11-1.52	0.001

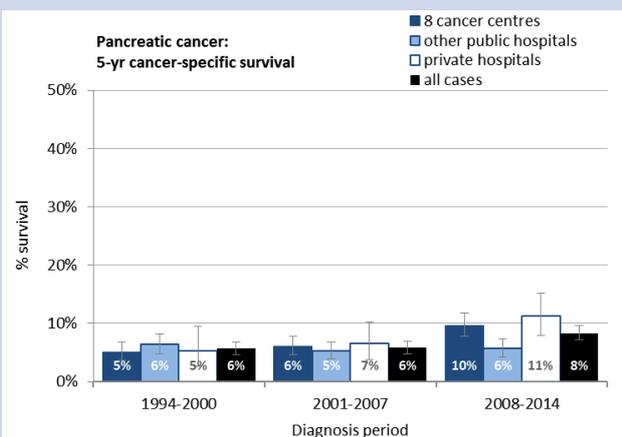


2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8+1 centres <sup>2</sup>	1.00	-	-
	Other public	<b>1.23</b>	1.10-1.38	<0.001
	Private	<b>0.81</b>	0.69-0.95	0.009

Summary Figure 2 Five-year cause-specific survival (by hospital category and period of diagnosis)

**Main cancer centres**

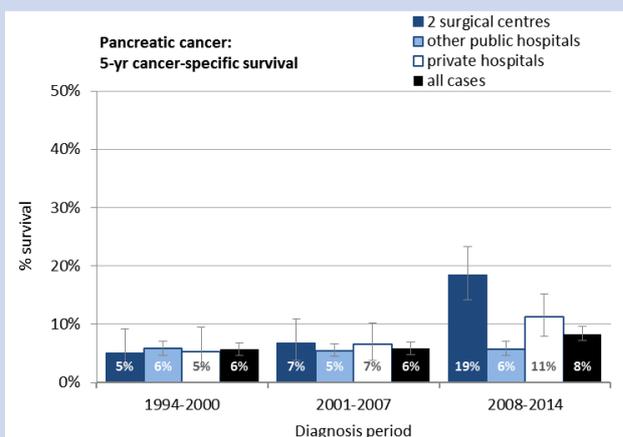
(by hospital of first surgery > biopsy > other treatment)



2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8 centres <sup>1</sup>	1.00	-	-
	Other public	<b>1.11</b>	1.00-1.22	0.042
	Private	0.90	0.78-1.03	0.124

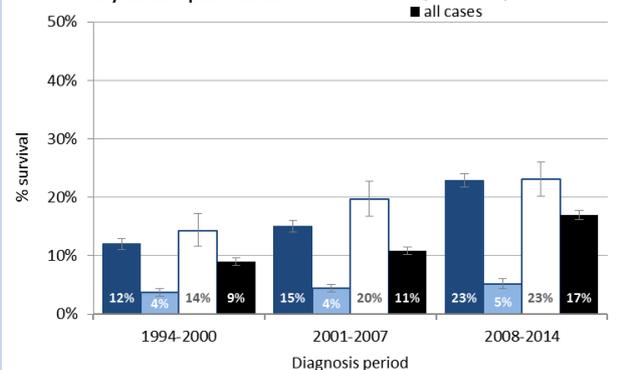
**Designated surgical centres**

(by hospital of first surgery)



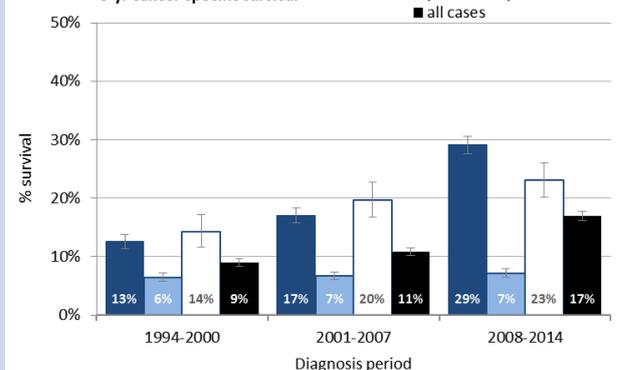
2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	2 centres <sup>3</sup>	1.00	-	-
	Other public	<b>1.29</b>	1.12-1.49	<0.001
	Private	1.06	0.89-1.26	0.536

**Lung cancer:**



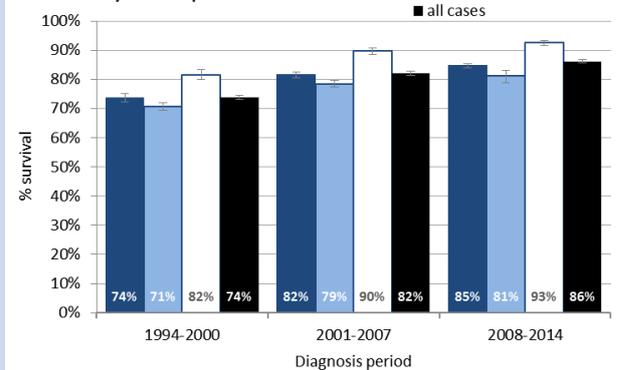
2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8 centres <sup>1</sup>	1.00	-	-
	Other public	<b>1.36</b>	1.29-1.42	<0.001
	Private	<b>0.89</b>	0.82-0.97	0.007

**Lung cancer:**



2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	4 centres <sup>3</sup>	1.00	-	-
	Other public	<b>1.44</b>	1.37-1.51	<0.001
	Private	1.00	0.92-1.09	0.960

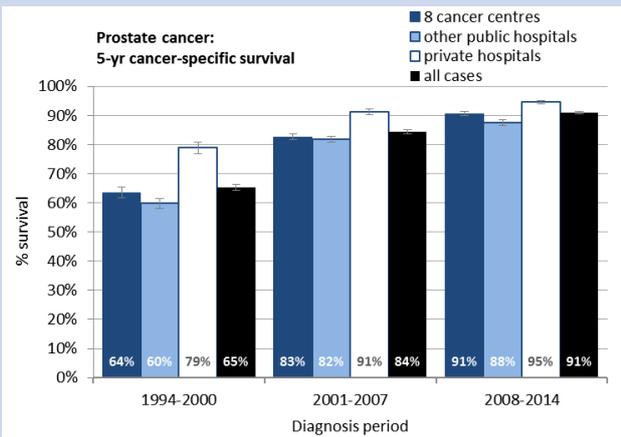
**Breast cancer:**



2008-2013 <sup>5</sup> adj for age, sex, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8+1 centres <sup>2</sup>	1.00	-	-
	Other public	<b>1.23</b>	1.06-1.45	0.007
	Private	<b>0.68</b>	0.58-0.79	<0.001

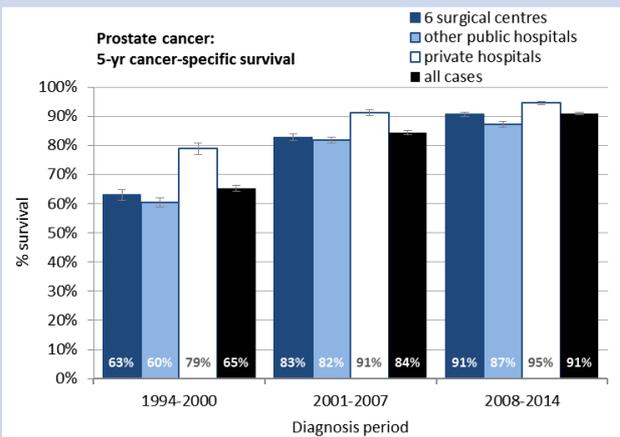
Summary Figure 2 Five-year cause-specific survival (by hospital category and period of diagnosis)

**Main cancer centres**  
(by hospital of first surgery > biopsy > other treatment)

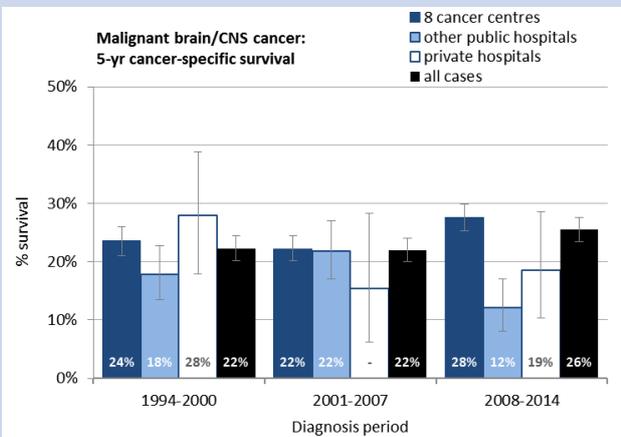


2008-2013 <sup>5</sup> adj for age, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8 centres <sup>1</sup>	1.00	-	-
	Other public	<b>1.31</b>	1.16-1.48	<0.001
	Private	<b>0.73</b>	0.62-0.85	<0.001

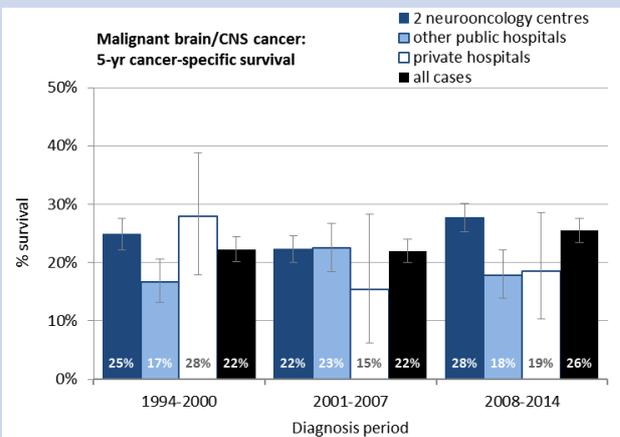
**Designated surgical centres**  
(by hospital of first surgery)



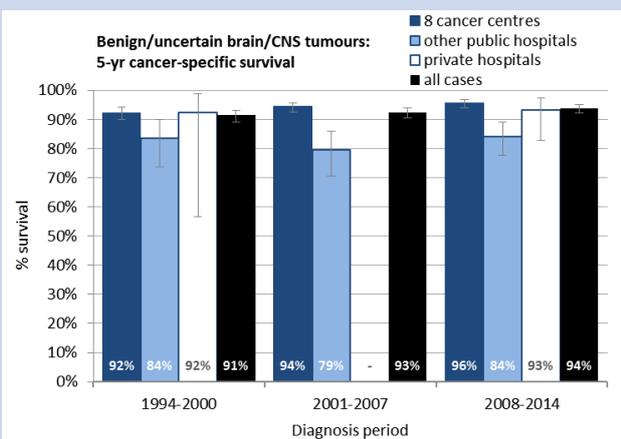
2008-2013 <sup>5</sup> adj for age, stage, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	6 centres <sup>2</sup>	1.00	-	-
	Other public	<b>1.32</b>	1.16-1.49	<0.001
	Private	<b>0.73</b>	0.62-0.88	<0.001



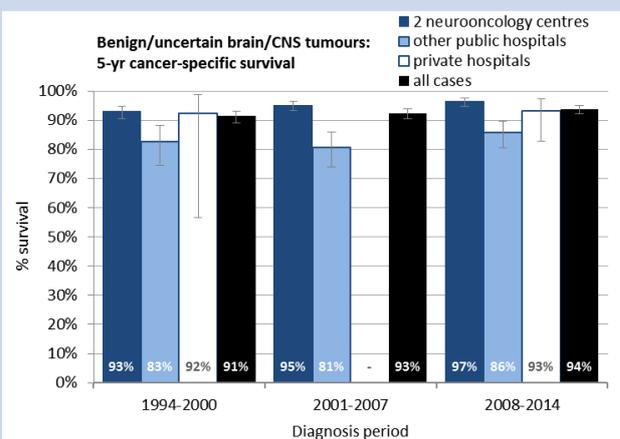
2008-2014 adjusted for age, sex, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8 centres <sup>1</sup>	1.00	-	-
	Other public	<b>1.45</b>	1.22-1.73	<0.001
	Private	1.06	0.82-1.38	0.646



2008-2014 adjusted for age, sex, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	2 centres <sup>3</sup>	1.00	-	-
	Other public	<b>1.20</b>	1.03-1.40	0.018
	Private	1.06	0.82-1.38	0.659



2008-2014 <sup>5</sup> adjusted for age, sex, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	8 centres <sup>1</sup>	1.00	-	-
	Other public	<b>1.92</b>	1.12-3.29	0.018
	Private	1.93	0.58-6.46	0.284



2008-2014 <sup>5</sup> adjusted for age, sex, deprivation	Hospital type	HR <sup>4</sup>	95% CI	P
	2 centres <sup>2</sup>	1.00	-	-
	Other public	<b>2.19</b>	1.22-3.94	0.009
	Private	2.21	0.65-7.50	0.203

<sup>1</sup> 8 centres designated for a range of cancers and as rapid access clinics for lung and prostate cancer.

<sup>2</sup> 8 centres (+ Letterkenny satellite to University College Hospital Galway) designated for rectal and breast cancer surgery and for breast cancer symptomatic disease.

<sup>3</sup> Centres designated for surgery for the specific cancer site.

<sup>4</sup> HR = age/sex/stage/deprivation-adjusted hazard ratio (compared with designated centres) excluding 2014 data for stage adjustment (different TNM edition); stage not available for brain/CNS tumours.

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- This work uses data provided by patients and collected by the health service as part of their care and support.

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