RESEARCH COMMUNICATION

Exploring Differences in Survival from Cancer among Indigenous and non-Indigenous Australians: Implications for Health Service Delivery and Research

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Abstract

The aim of this study is to compare cancer survivals of Indigenous and non-Indigenous Australians and consider health-service and research implications Cancer registry data from South Australia were used to calculate disease-specific survivals for Indigenous (n=671) and sampled non-Indigenous (n=15,799) patients diagnosed during 1977-2007, using Kaplan-Meier estimates and Cox proportional hazards regression. Indigenous and non-Indigenous five-year survivals were respectively: 40% and 57% for all cancer sites combined; 61% and 80% for female breast; 34% and 56% for colon/rectum; and 63% and 73% for cervix; whereas one-year survivals for cancers of unknown primary site were 5% and 22% respectively. Conversely, although not statistically significant (p=0.262), lung cancer survival tended to be higher in Indigenous than non-Indigenous patients. For all sites combined, Indigenous patients had lower survivals up to 70-79 years. The relative risk of death in Indigenous compared with non-Indigenous patients was 2.0 after adjusting for socio-demographic factors and diagnostic period, reducing to 1.4 when also adjusting for prognosis by primary site. Relative risks were 3.7 and 2.7 respectively for Indigenous compared with non-Indigenous patients from Far North remote communities. We conclude that relative risks for Indigenous compared with non-Indigenous patients for all cancers combined are elevated, as seen in the Northern Territory and Queensland. Despite uncertain accuracy of recording of Indigenous status, independent studies show risk elevations and point to the need to prevent cancers, particularly those of high lethal potential, to detect cancers earlier, and to complete planned treatment. A concerted health-service response is needed to address contributing geographic, socio-economic and cultural factors.

Keywords: Indigenous - non-Indigenous - 5 year survival - cancer

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Introduction

Aboriginal and Torres Strait Islander people are the Indigenous population of Australia comprising about 2.5% of the national population (ABS, 2008; ABS & AIHW, 2008; Cunningham et al., 2008). Approximately a quarter live in remote or very remote rural communities which is about 12 times the corresponding proportion for non-Indigenous people. The health status of Indigenous people is often affected adversely by severe socioeconomic disadvantage, cultural marginalisation and geographic remoteness. While their cancer incidence for all cancers combined is similar to, or slightly lower than for other Australians (non-melanoma skin cancers excluded), their cancer death rates are about 50% higher, making cancer the third leading cause of death in males and the second leading cause in females (ABS, 2008; ABS and AIHW, 2008; Cunningham et al., 2008).

Cancer survivals are lower in Indigenous than other Australians (SACR, 1997; Condon et al., 2003; Condon et al., 2005a; Condon et al., 2006; Valery et al., 2006; Cunningham et al., 2008), partly because they encounter more cancer types with high case fatalities, such as cancers of the lung, pancreas, liver, gallbladder, oral/pharynx/oesophagus, and unknown primary site, and in some areas, stomach (Coory et al., 2000; Threlfall and Thompson, 2002; Condon et al., 2003; Zhao et al., 2004; Roder, 2005; Cottrell et al., 2007; Zhang et al., 2007; ABS and AIHW, 2008; Cunningham et al., 2008; Zhang et al., 2008). By comparison, cancers with relatively low case fatalities such as prostate, female breast, colon/rectum and skin (melanoma) are generally less common in Indigenous patients.

Disease-specific survivals for all cancer sites combined have varied geographically, but commonly they have been at least a third lower in Indigenous than non-Indigenous patients (SACR, 1997; Condon et al., 2005a; Condon et al., 2006; Valery et al., 2006; Cunningham et al., 2008). In a Northern Territory study of cancers diagnosed in 1991-2001, Indigenous patients were 1.9 times more likely to die from their cancers after adjusting for differences in cancer site, age and sex (Condon et al., 2005a). In a

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Queensland study in 1997-2002, Indigenous patients were 1.5 times more likely to die from their cancers after these adjustments (Valery et al., 2006). Partly the elevation in case fatality in Indigenous patients can be attributed to more advanced stages at diagnosis, but there is evidence from Queensland (Valery et al., 2006), South Australia (SACR, 1997), and Indigenous language speakers in the Northern Territory (Condon et al., 2005b; Condon et al., 2005c; Condon et al., 2006), that factors other than stage contribute, such as high levels of co-morbidity and less complete treatment (SACR, 1997; Shaw and Elston, 2003; Hall et al, 2003; 2004a; 2004b; Condon et al., 2005b; 2005c; 2006; Subramaniam et al., 2005; Valery et al., 2006).

The present project explores differences in cancer survival between Indigenous and non-Indigenous patients. These differences are investigated by age, sex, place of residence, and where numbers of cancers are sufficient, by primary cancer site. In addition, differences are explored by diagnostic period to assess whether the survival gap between Indigenous and non-Indigenous patients is increasing or decreasing.

Incompleteness of recording of Indigenous status has been a major issue in Australian health statistics collections, including cancer registries which obtain Indigenous status from secondary sources, such as hospital and death records (Condon et al., 2004; AIHW and ABS, 2006; Cunningham et al., 2008). While this may not influence survival figures as much as incidence and mortality rates, where recording of Indigenous status needs to conform to population census standards, survival results still need to be interpreted with caution and in the context of results from other sources.

Materials and Methods

Data collection

Source data were obtained from the South Australian Cancer Registry for this project. The registry has received statutory notifications of invasive cancers since 1977, is population-based, and covers all regions of the State. Its procedures have been described previously (SACR, 2000). Death data are collected through routine notifications, electronic searches of official State death records, the National Death Index at the Australian Institute of Health and Welfare, and from interstate registries. Under-ascertainment has been checked through active follow-up, and with deaths reported independently, and found to be minimal, with little effect on calculated survival (Bonett et al., 1988; SACR, 2000).

This project included 671 patients recorded as Aboriginal or Torres Strait Islander with a diagnosis between 1977 and 2007, together with a “1 in 12” sample of non-Indigenous patients selected at random after stratification by year of diagnosis. The main factor limiting statistical power in this study was the number of Indigenous patients available for analysis. The decision to sample non-Indigenous cancers was made to allow closer checking of data accuracy, including case-by-case checking of Indigenous status against independent Indigenous indicators (such as postcodes of Indigenous communities) and the accuracy of a prognostic index derived from primary site of the cancer.

The identification of Indigenous status was made at hospital admission and at death registration using the classification system advocated for national health data (AIHW, 2004). National review has shown that the quality of Indigenous identification to be relatively good by national standards in South Australian hospital and death records (ABS and AIHW, 2008). Socio-demographic descriptors used in this study included age at diagnosis, sex, and region of residence, classified as 20 statistical sub-divisions and as metropolitan or non-metropolitan (SACR, 2000).

Statistical analyses

A de-identified file was developed and analysed in-house under provisions of the South Australian Health Care Act 2008, employing STATA 9.2 software (StataCorp, 2005). Case survivals were calculated, with a date of censoring of live cases of December 31st, 2007, recognising that a small under-ascertainment of deaths may still remain for 2007 (mostly from non-cancer causes) which might have had a small effect on results.

Kaplan-Meier product-limit estimates of disease-specific survival were calculated, treating deaths from other causes as censored observations (Armitage and Berry, 1987; StataCorp, 2005). Multivariable Cox proportional hazards regression was also undertaken to assess socio-demographic and secular predictors of survival outcomes(Armitage and Berry, 1987; StataCorp, 2005). The regression analysis employed the same censoring criteria as for the Kaplan-Meier analyses. All socio-demographic variables and period of diagnosis were entered into the analysis with backwards elimination where the fit of the model did not decrease in response ($p>0.05$). Assumptions underlying the analysis, including proportionality and an absence of co-linearity, were found to be satisfied (Armitage and Berry, 1987; StataCorp, 2005).

Disease-specific survival was employed rather than relative survival or excess mortality methods because life tables were not uniformly available for Indigenous and non-Indigenous people by place of residence and diagnostic period. Although analyses have shown similar survival estimates in South Australia, irrespective of whether relative or disease-specific survivals were used, these analyses were not specific to Indigenous cases and the results of the present project results should therefore be interpreted with some caution (SACR, 1997).

Analyses by cancer site were possible for lung, colon/rectum, female breast, cervix and unknown primary site, but not other sites due to small numbers ($n<35$). To gain an indication of comparative outcomes for Indigenous and non-Indigenous patients after allowing for differences in prognosis by cancer site, a prognostic index score was assigned to each site, comprising the most recent five-year relative survival published for that site for South Australia as a whole (SACR, 2000; 2007).

Two sets of multivariable regression analyses were undertaken, the first excluding and the second including the prognostic index.

Results

Site distribution and prognostic index

Cancer-site distributions differed markedly between the Indigenous and non-Indigenous patients (p<0.001). Compared with the non-Indigenous, Indigenous patients had higher numbers of the following cancer sites per 100 patients: head & neck (8.9 Vs 2.7); oesophagus (2.5 Vs 1.2); stomach (3.9 Vs 2.6); liver/gallbladder (5.1 Vs 1.5); lung (15.1 Vs 10.7); cervix (5.4 Vs 1.2); vagina/vulva (1.2 Vs 0.4); thyroid (2.7 Vs 0.9); and unknown primary site (6.6 Vs 3.5). By comparison, Indigenous patients had lower numbers of the following cancer sites per 100 patients: lip (0.7 Vs 2.5); colon/rectum (8.5 Vs 14.5); skin (melanoma) (0.7 Vs 7.6); female breast (8.6 Vs 11.7); and prostate (4.6 Vs 13.0). Due to difference in site distribution, the mean prognostic index was lower at 43.3% for Indigenous compared with 54.9% for non-Indigenous patients.

Comparisons of Indigenous and non-Indigenous patient survivals by age and primary site

Five-year survivals for all cancer sites combined were 40.0% for Indigenous and 56.8% for non-Indigenous patients. Indigenous patients had lower survivals in all age groups up to 70-79 years, with the most marked difference applying to 50-59 year olds where five-year survivals were 28.1% and 65.3% respectively (Table 1). Little difference was evident in patients aged 80 years or more, although the number of Indigenous people in this age bracket was small, leading to large standard errors. Comparisons by cancer site showed lower survivals for Indigenous than non-Indigenous cases for female breast, colon/rectum, potentially cervix (p=0.057), and unknown primary site (p=0.008), but not for lung where a non-significantly elevation in survival applied to Indigenous patients (p=0.262) (Table 2).

Comparisons of Indigenous patient survivals by age, sex, place of residence and diagnostic period

Older Indigenous patients had lower survivals than younger Indigenous patients for all cancer sites combined in the age range under 60 years, but not in the older patients (Table 3). Survivals differed for males and females, with five-year figures of 34.1% and 45.0% respectively, and also by place of residence with patients from the Far North Statistical Sub-division and potentially other country areas having lower survivals than those from Adelaide. Differences in survival were not statistically significant across other statistical sub-divisions (p>0.100), although the West Coast sub-division (remote Far West Coast region) had a low five-year survival of 26.7%, albeit based on a small case number (n=46). Survivals did not differ significantly by diagnostic period (p=0.209), nor was there a consistent secular increase or decrease.

Table 1. % Case Survival (± standard error) among Indigenous and Non-Indigenous Cancer Patients: All Cancer Sites, South Australia, 1977-2007*

			Years from diagnosis								
Age at diag. (yrs.)	Indigenous status		1	2	3	4	5	10	15	20	P value**
Under 40	Yes [n=89]	100	72.7 ±4.8	67.9 ±5.0	64.1 ±5.2	61.5 ±5.3	61.5 ±5.3	52.3 ±5.9	45.3 ±6.9	45.3 ±6.9	p<0.001
	No [n=987]	100	93.0 ±0.8	87.8 ±1.1	85.6 ±1.1	83.3 ±1.2	81.6 ±1.3	76.9 ±1.4	74.8 ±1.5	74.2 ±1.6	
40-49	Yes [n=131]	100	64.5 ±4.3	60.9 ±4.4	56.1 ±4.6	50.0 ±4.7	47.8 ±4.7	41.7 ±5.1	39.5 ±5.3	28.8 ±7.6	p<0.001
	No [n=1,240]	100	86.9 ±1.0	80.0 ±1.2	75.9 ±1.3	73.6 ±1.3	71.0 ±1.4	66.3 ±1.5	62.7 ±1.6	61.1 ±1.7	
50-59	Yes [n=174]	100	49.6 ±3.9	38.8 ±3.9	34.9 ±3.9	31.6 ±3.8	28.1 ±3.8	24.0 ±3.7	21.4 ±4.2	21.4 ±4.2	p<0.001
	No [n=2,297]	100	81.1 ±0.8	73.8 ±0.9	69.9 ±1.0	67.5 ±1.0	65.3 ±1.0	59.1 ±1.1	54.8 ±1.3	53.0 ±1.3	
60-69	Yes [n=155]	100	62.7 ±4.0	53.0 ±4.3	44.7 ±4.4	38.7 ±4.7	35.4 ±4.5	26.0 ±5.0	26.0 ±5.0	19.5 ±6.7	p<0.001
	No [n=3,979]	100	75.4 ±0.7	67.7 ±0.8	62.9 ±0.8	60.2 ±0.8	58.2 ±0.8	52.3 ±0.9	48.8 ±1.0	45.4 ±1.2	
70-79	Yes [n=80]	100	56.0 ±5.7	48.0 ±5.9	43.8 ±6.1	35.4 ±6.2	33.2 ±6.2	27.8 ±6.3	27.8 ±6.3	18.6 ±8.6	p<0.001
	No [n=4,603]	100	70.4 ±0.7	61.9 ±0.7	57.3 ±0.8	53.2 ±0.8	50.3 ±0.8	42.6 ±0.9	38.4 ±1.1	34.2 ±1.7	
80+	Yes [n=42]	100	57.3 ±7.9	48.7 ±8.1	45.9 ±8.1	45.9 ±8.1	41.3 ±8.5	-	-	-	p=0.706
	No [n=2,693]	100	59.6 ±1.0	50.7 ±1.0	45.8 ±1.1	42.2 ±1.1	40.2 ±1.1	31.8 ±1.4	29.3 ±1.7	26.4 ±3.2	
Total	Yes [n=671]	100	59.9 ±1.9	52.1 ±2.0	47.2 ±2.1	42.5 ±2.1	40.0 ±2.1	32.9 ±2.2	30.4 ±2.4	26.3 ±2.8	p<0.001
	No [n=15,799]	100	74.2 ±0.4	66.4 ±0.4	62.1 ±0.4	59.1 ±0.4	56.8 ±0.4	50.8 ±0.5	47.6 ±0.5	45.6 ±0.6	

*Kaplan-Meier product-limit estimates of survival from index cancer; Date of censoring: December 31st, 2007; Non-Indigenous patient sample (1 in 12) (see text); **P value derived from Cox proportional hazards regression; Data source: SA Cancer Registry

Table 2. % Case Survival (± standard error) among Indigenous and Non-Indigenous Cancer Patients by Primary Cancer Site: South Australia, 1977-2007*

			Years from diagnosis								
Primary site	Indigenous status		1	2	3	4	5	10	15	20	P value**
			37.8	27.8	23.1	18.2	18.2	13.5	13.5	-	
Lung	Yes [n=101]	100	±5.1	±5.0	±4.8	±4.5	±4.5	±4.5	±4.5		p=0.262
			35.9	20.2	15.5	13.2	12.5	9.0	7.2	6.8	
	No [n=1,686]	100	±1.2	±1.0	±0.9	±0.9	±0.9	±0.9	±0.9	±0.9	
			91.4	85.6	76.2	66.1	60.8	49.7	49.7	-	
Female breast	Yes [n=58]	100	±3.7	±4.7	±6.1	±7.1	±7.5	±7.9	±7.9		p=0.005
			95.4	91.0	86.7	82.9	79.6	70.6	65.4	62.7	
	No [n=1,850]	100	±0.5	±0.7	±0.8	±0.9	±1.0	±1.3	±1.5	±1.7	
			68.9	56.2	49.7	36.5	34.1	21.6	21.6	-	
Large bowel	Yes [n=57]	100	±6.3	±6.9	±7.1	±7.0	±6.9	±8.0	±8.0		p=0.004
(colon/rectum)			77.4	68.5	±7.1	58.5	55.6	49.4	47.6	45.6	
	No [n=2,297]	100	±0.9	±1.0	±1.1	±1.1	±1.1	±1.2	±1.3	±1.5	
			4.9	-	-	-	-	-	-	-	
Unknown	Yes [n=44]	100	±3.4								p=0.008
(CUP)			21.9	16.2	13.7	12.8	12.8	10.2	9.2	7.6	
	No [n=559]	100	±1.8	±1.7	±1.6	±1.6	±1.6	±1.7	±1.8	±2.0	
			73.1	73.1	73.1	62.6	62.6	55.7	50.6	50.6	
Cervix	Yes [n=36]	100	±7.7	±7.7	±7.7	±8.6	±8.6	±9.0	±9.5	±9.5	p=0.057
			89.6	81.2	77.6	75.2	73.2	71.7	69.6	68.2	
	No [n=185]	100	±2.3	±2.9	±3.1	±3.3	±3.4	±3.5	±3.7	±3.9	

*Kaplan-Meier product-limit estimates of survival from index cancer; Date of censoring: December 31st, 2007; Non-Indigenous patient sample (1 in 12) (see text); **P value derived from Cox proportional hazards regression; Data source: SA Cancer Registry

Table 3. % Case Survival (± standard error) among Indigenous Cancer Patients by Age, Sex, Place of Residence and Diagnostic Period: All Cancer Sites, South Australia, 1977-2007*

		Years from diagnosis								
		1	2	3	4	5	10	15	20	P value**
Age at diagnosis (yrs.):										
		72.7	67.9	64.1	61.5	61.5	52.3	45.3	45.3	
Under 40 [n=89]	100	±4.8	±5.0	±5.2	±5.3	±5.3	±5.9	±6.9	±6.9	
		64.5	60.9	56.1	50.0	47.8	41.7	39.5	28.8	
40-49 [n=131]	100	±4.3	±4.4	±4.6	±4.7	±4.7	±5.1	±5.3	±7.6	
		49.6	38.8	34.9	31.6	28.1	24.0	21.4	21.4	
50-59 [n=174]	100	±3.9	±3.9	±3.9	±3.8	±3.8	±3.7	±4.2	±4.2	p<0.001
		62.7	53.0	44.7	38.7	35.4	26.0	26.0	19.5	
60-69 [n=155]	100	±4.0	±4.3	±4.4	±4.7	±4.5	±5.0	±5.0	±6.7	
		56.0	48.0	43.8	35.4	33.2	27.8	27.8	18.6	
70-79 [n=80]	100	±5.7	±5.9	±6.1	±6.2	±6.2	±6.3	±6.3	±8.6	
		57.3	48.7	45.9	45.9	41.3	-	-	-	
80+ [n=42]	100	±7.9	±8.1	±8.1	±8.1	±8.5				
Sex:										
		55.2	46.5	40.6	36.9	34.1	26.5	22.4	18.1	
Male [n=321]	100	±2.9	±2.9	±3.0	±3.0	±3.0	±3.3	±3.6	±4.0	p=0.003
		64.0	57.1	53.0	47.5	45.0	38.3	37.4	33.3	
Female [n=350]	100	±2.6	±2.7	±2.8	±2.9	±2.9	±3.0	±3.1	±3.9	
Place of residence:										
		62.3	58.2	52.1	47.7	46.0	38.3	33.1	30.1	
Adelaide [n=263]	100	±3.1	±3.2	±3.3	±3.4	±3.4	±3.8	±4.3	±4.8	
		48.1	37.4	35.8	31.1	27.9	21.5	21.5	16.1	p=0.003
Far North [n=90]	100	±5.4	±5.4	±5.4	±5.3	±5.2	±5.3	±5.3	±6.1	
		61.2	51.2	46.3	41.5	38.4	31.7	30.6		
Other [n=318]	100	±2.8	±2.9	±3.0	±3.0	±3.0	±3.2	±3.3	26.3±4.0	
Diagnostic period:										
		69.1	61.8	54.5	50.3	48.2	37.6	34.4	28.6	
1977-86 [n=103]	100	±4.6	±4.9	±5.0	±5.1	±5.1	±5.1	±5.1	±5.2	
		55.7	47.5	42.2	36.5	34.8	31.4	29.2	26.8	
1987-96 [n=222]	100	±3.4	±3.4	±3.4	±3.4	±3.4	±3.4	±3.5	±4.0	p=0.209
		59.8	52.2	48.6	44.4	40.7	25.4	-	-	
1997-07 [n=346]	100	±2.7	±2.9	±3.0	±3.0	±3.1	±7.8			

*Kaplan-Meier product-limit estimates of survival from index cancer; Date of censoring: December 31st, 2007; **P value derived from Cox proportional hazards regression; Data source: SA Cancer Registry

Table 4. Relative Risk (95% confidence limits) of Death from Cancer in South Australia by Age, Sex, Place of Residence, Diagnostic Period and Indigenous status*

	Relative risk					
	All patients [n=16,470]		Indigenous patients [n=671]		Non-Indigenous patients [n=15,799]	
Age at diagnosis (yrs.):						
Under 40	1.00	[n=1,076]	1.00	[n=89]	1.00	[n=987]
40-49	1.67 (1.44, 1.95)	[n=1,371]	1.41 (0.95, 2.10)	[n=131]	1.70 (1.44, 2.00)	[n=1,240]
50-59	2.15 (1.88, 2.47)	[n=2,471]	2.19 (1.52, 3.16)	[n=174]	2.14 (1.85, 2.48)	[n=2,297]
60-69	2.54 (2.23, 2.90)	[n=4,134]	1.68 (1.15, 2.45)	[n=155]	2.65 (2.30, 3.05)	[n=3,979]
70-79	3.34 (2.93, 3.80)	[n=4,683]	1.94 (1.27, 2.97)	[n=80]	3.48 (3.03, 4.00)	[n=4,603]
80+	4.87 (4.26, 5.57)	[n=2,735]	2.00 (1.20, 3.33)	[n=42]	5.13 (4.45, 5.92)	[n=2,693]
Sex:						
Male	1.00	[n=9,078]	1.00	[n=321]	1.00	[n=8,757]
Female	0.85 (0.81, 0.89)	[n=7,392]	0.71 (0.58, 0.87)	[n=350]	0.85 (0.81, 0.90)	[n=7,042]
Place of residence:						
Adelaide	1.00	[n=11,977]	1.00	[n=263]	1.00	[n=11,714]
Far North	1.37 (1.08, 1.74)	[n=134]	1.57 (1.16, 2.13)	[n=90]	0.99 (0.59, 1.64)	[n=44]
Other	1.07 (1.01, 1.12)	[n=4,359]	1.08 (0.87, 1.35)	[n=318]	1.07 (1.01, 1.13)	[n=4,041]
Diagnostic period:						
1977-86	1.00	[n=3,587]	1.00	[n=103]	1.00	[n=3,484]
1987-96	0.73 (0.69, 0.77)	[n=5,312]	1.27 (0.95, 1.71)	[n=222]	0.71 (0.67, 0.75)	[n=5,090]
1997-07	0.60 (0.57, 0.64)	[n=7,571]	1.14 (0.85, 1.53)	[n=346]	0.58 (0.55, 0.62)	[n=7,225]
Indigenous status:						
No	1.00	[n=15,799]	-	[-]	-	[-]
Yes	1.98 (1.77, 2.21)	[n=671]	-	[-]	-	[-]

*Cox proportional hazards regression; Date of censoring: December 31st, 2007; Non-Indigenous patient sample (1 in 12) (see text); Data source: SA Cancer Registry

Table 5. Cancer-Prognosis Adjusted Relative Risk (95% confidence limits) of Death from Cancer in South Australia by Age, Sex, Place of Residence, Diagnostic Period and Indigenous Status*

	Relative risk					
	All patients [n=16,470]		Indigenous patients [n=671]		Non-Indigenous patients [n=15,799]	
Age at diagnosis (yrs.):						
Under 40	1.00	[n=1,076]	1.00	[n=89]	1.00	[n=987]
40-49	1.58 (1.35, 1.83)	[n=1,371]	1.34 (0.90,1.98)	[n=131]	1.60 (1.36, 1.89)	[n=1,240]
50-59	1.69 (1.47, 1.93)	[n=2,471]	1.67 (1.16,2.41)	[n=174]	1.67 (1.44, 1.94)	[n=2,297]
60-69	1.87 (1.64, 2.13)	[n=4,134]	1.45 (0.99,2.12)	[n=155]	1.90 (1.65, 2.19)	[n=3,979]
70-79	2.51 (2.20, 2.86)	[n=4,683]	2.10 (1.37,3.21)	[n=80]	2.54 (2.21, 2.92)	[n=4,603]
80+	3.75 (3.28, 4.29)	[n=2,735]	2.17 (1.30,3.62)	[n=42]	3.84 (3.32, 4.44)	[n=2,693]
Sex:						
Male	1.00	[n=9,078]	1.00	[n=321]	1.00	[n=8,757]
Female	0.99 (0.94, 1.03)	[n=7,392]	0.88 (0.72,1.08)	[n=350]	0.99 (0.94, 1.04)	[n=7,042]
Place of residence:						
Adelaide	1.00	[n=11,977]	1.00	[n=263]	1.00	[n=11,714]
Far North	1.46 (1.15, 1.84)	[n=134]	1.70 (1.25,2.30)	[n=90]	1.03 (0.62, 1.72)	[n=44]
Other	1.12 (1.06, 1.18)	[n=4,359]	1.09 (0.87,1.36)	[n=318]	1.12 (1.06, 1.18)	[n=4,041]
Diagnostic period:						
1977-86	1.00	[n=3,587]	1.00	[n=103]	1.00	[n=3,484]
1987-96	0.76 (0.72, 0.81)	[n=5,312]	1.19 (0.88,1.60)	[n=222]	0.75 (0.70, 0.79)	[n=5,090]
1997-07	0.61 (0.58, 0.65)	[n=7,571]	1.05 (0.78,1.41)	[n=346]	0.60 (0.56, 0.64)	[n=7,225]
Prognostic index (%):						
Stated %	1.00		1.00		1.00	
Stated % +1%	0.97 (0.97, 0.97)	[n=16,470]	0.97 (0.97,0.98)	[n=671]	0.97 (0.97, 0.97)	[n=15,799]
Indigenous status:						
No	1.00	[n=15,799]	--	[-]	--	[-]
Yes	1.37 (1.23, 1.53)	[n=671]	--	[-]	--	[-]

*Cox proportional hazards regression; Date of censoring: December 31st, 2007; Non-Indigenous patient sample ....(1 in 12) (see text); Data source: SA Cancer Registry

Multivariable proportional hazards regression

Table 4 indicates that Indigenous patients had an approximate two-fold relative risk (RR) of death from their primary cancer (RR=1.98) compared with non-Indigenous patients after adjusting for age, sex, place of residence and diagnostic period. Unlike non-Indigenous patients, where the relative risk increased progressively with age, the relative risk for Indigenous patients peaked at 50-59 years. Other differences included an elevated relative risk among Indigenous but not non-Indigenous patients from the Far North and a decrease in relative risk for more recent diagnostic period for non-Indigenous but

Table 6. Relative Risk (95% confidence limits) of Death from Cancer in South Australia by Age, Sex, Diagnostic Period and Indigenous Status, According to Place of Residence*

	Relative risk					
	Adelaide patients [n=11, 977]		Other patients (excl. Far North) [n=4,359]		Far North patients [n=134]	
Age at diagnosis (yrs.):						
Under 40	1.00	[n=756]	1.00	[n=299]	1.00	[n=21]
40-49	1.81 (1.51, 2.18)	[n=962]	1.33 (1.01, 1.75)	[n=389]	2.07(0.79, 5.42)	[n=20]
50-59	2.18 (1.85, 2.59)	[n=1,736]	2.11 (1.66, 2.69)	[n=699]	1.38 (0.57, 3,33)	[n=36]
60-69	2.70 (2.29, 3.17)	[n=2,946]	2.25 (1.78, 2.84)	[n=1,151]	1.52 (0.63, 3.69)	[n=37]
70-79	3.59 (3.06, 4.21)	[n=3,482]	2.85 (2.26, 3.59)	[n=1,186]	1.58 (0.57, 4.37)	[n=15]
80+	5.05 (4.29, 5.95)	[n=2,095]	4.64 (3.65, 5.90)	[n=635]	2.68 (0.67, 10.75)	[n=5]
Sex:						
Male	1.00	[n=6,517]	1.00	[n=2,493]	1.00	[n=68]
Female	0.85 (0.80, 0.90)	[n=5,460]	0.87 (0.79, 0.95)	[n=1,866]	0.57 (0.35, 0.93)	[n=66]
Diagnostic period:						
1977-86	1.00	[n=2,709]	1.00	[n=858]	1.00	[n=20]
1987-96	0.71 (0.66, 0.76)	[n=3,846]	0.76 (0.68, 0.85)	[n=1,416]	1.82 (0.89, 3.76)	[n=50]
1997-07	0.59 (0.55, 0.63)	[n=5,422]	0.61 (0.54, 0.68)	[n=2,085]	1.57 (0.75, 3.28)	[n=64]
Indigenous status:						
No	1.00	[n=11,714]	1.00	[n=4,041]	1.00	[n=44]
Yes	1.94 (1.63, 2.30)	[n=263]	1.93 (1.66, 2.25)	[n=318]	3.73 (2.02, 6.87)	[n=90]

*Cox proportional hazards regression; Date of censoring: December 31^{st}, 2007; Non-Indigenous patient sample (1 in 12) (see text); Data source: SA Cancer Registry

Table 7. Cancer-Prognosis Adjusted Relative Risk (95% confidence limits) of Death from Cancer in South Australia by Age, Sex, Diagnostic Period and Indigenous Status, According to Place of Residence*

	Relative risk					
	Adelaide patients [n=11,977]		Other patients (excl. Far North) [n=4,359]		Far North patients [n=134]	
Age at diagnosis (yrs.):						
Under 40	1.00	[n=756]	1.00	[n=299]	1.00	[n=21]
40-49	1.53 (1.27, 1.84)	[n=962]	1.59 (1.21, 2.10)	[n=389]	2.54 (0.97, 6.65)	[n=20]
50-59	1.55 (1.31, 1.83)	[n=1,736]	2.02 (1.59, 2.58)	[n=699]	1.72 (0.70, 4.20)	[n=36]
60-69	1.83 (1.55, 2.15)	[n=2,946]	1.96 (1.55, 2.48)	[n=1,151]	1.64 (0.66, 4.06)	[n=37]
70-79	2.44 (2.08, 2.86)	[n=3,482]	2.63 (2.08, 3.32)	[n=1,186]	2.68 (0.98, 7.32)	[n=15]
80+	3.51 (2.97, 4.13)	[n=2,095]	4.44 (3.48, 5.67)	[n=635]	2.94 (0.71, 12.24)	[n=5]
Sex:						
Male	1.00	[n=6,517]	1.00	[n=2,493]	1.00	[n=68]
Female	1.01 (0.95, 1.06)	[n=5,460]	0.96 (0.87, 1.05)	[n=1,866]	0.76 (0.46, 1.24)	[n=66]
Diagnostic period:						
1977-86	1.00	[n=2,709]	1.00	[n=858]	1.00	[n=20]
1987-96	0.75 (0.70, 0.81)	[n=3,846]	0.76 (0.68, 0.85)	[n=1,416]	1.99 (0.94, 4.21)	[n=50]
1997-07	0.63 (0.59, 0.68)	[n=5,422]	0.55 (0.49, 0.61)	[n=2,085]	1.80 (0.85, 3.85)	[n=64]
Prognostic index (%):						
Stated %	1.00	[n=11,977]	1.00	[n=4,359]	1.00	[n=134]
Stated % +1%	0.97 (0.97, 0.97)		0.97 (0.97, 0.97)		0.97 (0.96, 0.98)	
Indigenous status:						
No	1.00	[n=11,714]	1.00	[n=4,041]	1.00	[n=44]
Yes	1.35 (1.14, 1.61)	[n=263]	1.33 (1.14, 1.55)	[n=318]	2.70 (1.44, 5.08)	[n=90]

*Cox proportional hazards regression; Date of censoring: December 31^{st}, 2007; Non-Indigenous patient sample (1 in 12) (see text); Data source: SA Cancer Registry

not for Indigenous patients. Females had lower relative risks than males irrespective of Indigenous status. Table 5 shows corresponding results to those in Table 4 after adjusting for prognostic index. There was still an increased relative risk of death for Indigenous patients but of lower magnitude (RR=1.37). Other patterns were similar in Indigenous and non-Indigenous patients to those described in Table 4, although the relative risks for females were no longer greatly reduced and the elevated risk of case fatality in 50-59 year old Indigenous patients was less prominent.

Table 6 shows an approximate two-fold elevation in relative risk in Indigenous than non-Indigenous patients in Adelaide (RR=1.94) and in other areas excluding the Far North (RR=1.93). A higher relative risk was suggested for Indigenous patients in the Far North (RR=3.73). Table 7 shows corresponding results to those in Table 6 after adjusting for prognostic index. A much smaller elevation in relative risk applied for Indigenous patients in Adelaide (RR=1.35) and other areas excluding the Far North (RR=1.33). Meanwhile the relative risk for Indigenous patients in the Far North, although high (RR=2.70), was also lower than observed when adjustment was not made for prognostic index.

Discussion

The five-year survival of 40% for all cancer sites combined in Indigenous patients is similar to the corresponding 37% observed in Indigenous patients in a 1988-94 study (SACR, 1997). Also the 57% for non-Indigenous patients is broadly similar to the corresponding 56% for non-Indigenous patients in 1988-94 (SACR, 1997; 2000). Indigenous patients had lower five-year survivals in the present project in each age group up to 70-79 years, with the largest difference occurring in the 50-59 year age range (i.e., 28% Indigenous survival compared with 65% non-Indigenous survival). While little difference in survival was suggested in patients over 80 years of age, the number of Indigenous cases in this age group was very small and survival estimates were subject to large random error. Also the small group of Indigenous patients surviving to this old age may have been highly selective.

Survivals for common cancer sites with sufficient numbers for analysis were higher for non-Indigenous than Indigenous patients, except for lung cancer where there was a non-significant survival advantage for Indigenous patients (p=0.262). This is consistent with Northern Territory data that showed Indigenous lung cancers to be less advanced at diagnosis than for non-Indigenous patients (Condon et al., 2005b; Condon et al., 2005c). It is possible that increased medical investigations associated with higher levels of respiratory morbidity in Indigenous patients may have contributed to earlier lung cancer diagnosis.

The elevated frequency among Indigenous patients of cancers of the head and neck, oesophagus, stomach, liver and gall bladder, lung, cervix, vagina/vulva, and unknown primary site is consistent with results of previous national and state/territory studies (Coory et al., 2000; Threlfall & Thompson., 2002; Condon et al., 2003; Zhao et al., 2004; Roder, 2005; Cottrell et al., 2007; Zhang et al., 2007; ABS and AIHW, 2008; Cunningham et al., 2008; Zhang et al., 2008) . Also the lower frequency among Indigenous patients of cancers of the lip, skin (melanoma), colon/rectum, female breast and prostate is consistent with previous results (Coory et al., 2000; Threlfall and Thompson., 2002; Condon et al., 2003; Zhao et al., 2004; Roder, 2005; Cottrell et al., 2007; Zhang et al., 2007; ABS and AIHW, 2008; Cunningham et al., 2008; Zhang et al., 2008).

Based on site-specific five-year relative survivals for the population overall, it would have been be expected from site distributions that five-year survival would have been about 43% for Indigenous and 55% for non-Indigenous patients. While the five-year survivals actually observed were very similar to these expected values at 40% and 57% respectively, the Indigenous patients were much younger (i.e., 33% under 50 years of age compared with a corresponding 14% for non-Indigenous patients) such that a smaller survival difference might have been expected (note: survivals from cancer are generally higher in younger patients (SACR, 2000; 2007).

The lower survivals observed in Indigenous cases in this project were largely due to differences in site distribution. The relative risk of case fatality in Indigenous compared with non-indigenous patients reduced from approximately 2.0 after adjusting for age, sex, place of residence and diagnostic period (site unadjusted) to 1.4 after when also adjusting for prognosis by cancer site. This relative risk of 1.4 is lower than the site-adjusted relative risks of 1.9 in the Northern Territory and closer to the corresponding 1.5 found in a Queensland study (Condon et al., 2006; Valery et al., 2006).

Much of the inequality in survival outcomes between Indigenous and non-Indigenous patients could be addressed through primary prevention of the more lethal cancer types found in Indigenous patients (Cunningham et al., 2008). In particular, it would be expected that reductions in tobacco smoking prevalence, which is elevated in Indigenous people, would lead to reductions in incidence of cancers of the lung, liver, oesophagus, and head and neck (Schottenfeld & Fraumeni, 1996); reductions in excess alcohol consumption, which is also common in some indigenous communities (Cunningham et al., 2008), would bring about decreases for cancers of the liver, oesophagus, and head and neck; and dietary improvements including increased fruit and vegetable consumption may lead to a decreases in incidence of cancers of the head and neck, oesophagus, and stomach (Schottenfeld and Fraumeni, 1996). Meanwhile hepatitis B vaccination of Indigenous newborn would protect against liver cancer (O'Sullivan et al., 2004), whereas improvements in living conditions and associated hygiene opportunities could lead to a reduced prevalence of helicobacter pylori infection and risk of stomach cancer (Windsor et al., 2005; Cunningham, 2008). Effects of preventive initiatives on incidence are potentially large but could take decades to occur due to long disease latencies.

Adjusting for prognosis by cancer site reduced but did not eliminate the increased risk of case fatality in Indigenous patients in this project. Earlier studies for South Australia, the Northern Territory and Queensland provided confirmatory findings and indicated that more advanced stages of cancers at diagnosis in Indigenous patients also contributed to their survival deficits (SACR, 1997; Condon et al., 2005b; Condon et al., 2005c; Valery et al., 2006). This indicates the importance of promoting cancer screening and allied means of earlier detection in Indigenous populations. It is relevant that data on breast and cervix screening indicate much lower levels of screening participation by Indigenous than non-Indigenous people (DOHA, 2009).

It is notable that cancer site distributions and more advanced cancer stages at diagnosis did not fully account for survival deficits in Indigenous patients in these earlier studies (SACR, 1997; Condon et al., 2005b; Condon et al., 2005c; Condon et al., 2006; Valery et al., 2006). Lower levels of treatment were identified in Indigenous than non-Indigenous patients in Queensland, the Northern Territory and Western Australia which may have contributed (Shaw & Elston, 2003; Hall et al, 2003; Hall & Holman, 2003; Subramaniam et al., 2003; Hall et al., 2004a; Hall et al., 2004b; Condon et al., 2005b; Condon et al., 2005c; Valery et al., 2006; Condon et al., 2005b; Condon et al., 2006). Treatment may be compromised by elevated levels of co-morbidity, including diabetes and cardiovascular, respiratory, and renal diseases, smoking and obesity, which are more prevalent in Indigenous people (ABS 2008; ABS and AIHW 2008; Cunningham et al., 2008). These conditions also may predispose to poorer cancer outcomes through increased frailty and a reduced physical capacity to cope with cancer and treatment side-effects. Poorer access of remote Indigenous populations to specialised treatment services would be another factor that could predispose to sub-optimum treatment and poorer outcomes (ABS 2008; ABS and AIHW 2008; Cunningham et al., 2008).

While there is evidence from the present study of a reducing case fatality in more recent diagnostic periods for non-Indigenous patients, this was not seen in Indigenous patients, such that the survival gap increased. Indigenous patients living in the Far North were at special risk of death with a prognosis-adjusted relative risk of 1.7 when compared with Indigenous patients in Adelaide. Compared with non-Indigenous patients from the respective regions, the relative risk was 1.4 for Indigenous patients living in Adelaide, 2.7 for those living in the Far North and 1.3 for those living in other country areas. While there was a particularly high risk of case fatality among Indigenous patients in the Far North, a corresponding increase in risk was not seen in non-Indigenous patients living in that region. A similar increase in risk was apparent in Indigenous patients from the Far West Coast, although numbers of cases were small and the risk estimate for that region would have been subject to large random variation.

It is concluded that the relative risk of cancer death for Indigenous compared with non-Indigenous patients for all cancers combined has been elevated in South Australia as seen in the Northern Territory and Queensland. Despite uncertain accuracy of recording of Indigenous status, independent studies show similar findings and point to the need for prevention, particularly for cancers of high lethal potential. In addition there is a need to detect cancers earlier in Indigenous people and find ways of increasing access to care. The high case fatality experienced by Indigenous patients underscores the need for palliative services, both in remote and urban settings, including effective pain control. A program of health-services research is needed to determine means of better delivering cancer services of all types (from prevention through to end-of-life care) to the Indigenous populations in varying urban and rural settings.

A concerted health-service response is needed to address geographic, socio-economic and cultural barriers to cancer prevention, screening and treatment in the Indigenous population. Indigenous researchers should be included as lead partners in this research effort and Indigenous policy makers and health administrators have lead roles to play in the implementation of research

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