RESEARCH COMMUNICATION

Exploring Trends in Laryngeal Cancer Incidence, Mortality and Survival: Implications for Research and Cancer Control

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Abstract

South Australian registry data were used to investigate trends in laryngeal cancer age-standardised incidence, mortality and disease-specific survival from 1977 to 2005. Incidence rates decreased by 32% from 1980-84 to 2000-05, affecting both sexes and ages under 70 years. There were concurrent reductions in mortality, although statistical significance was not achieved with the numbers of deaths examined (p>0.05). More than other cancers, laryngeal cancers presented in: the 50-79 year age range; males, particularly those born in Southern Europe; UK/Irish migrants; and residents of lower socio-economic areas. Compared with other cancers, laryngeal cancers were less common in more recent diagnostic periods. The ratio of glottis to other laryngeal cancers was higher in males, older patients, and those born in Southern Europe, UK/Ireland and Western Europe. A secular increase in this ratio was evident. The five-year survival from laryngeal cancer was 68%, with poorer outcomes applying for older patients, non-metropolitan residents, patients with cancers of laryngeal sub-sites other than glottis, and potentially patients born in Southern Europe. Secular changes in survival were not observed. Reductions in incidence are attributed to decreases in tobacco smoking in males and reductions in per capital alcohol consumption since the 1970s. The higher ratio of glottis to other laryngeal cancer sub-sites in males may indicate a greater contribution made by tobacco, as opposed to alcohol, in males. The lower survival observed in non-metropolitan patients may reflect poorer access to radiation oncology and other specialist services, although delays in diagnosis for other reasons may have contributed.

Key Words: Laryngeal cancer - incidence - mortality - survival - glottis - other sub-sites - trends

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Introduction

Laryngeal cancer is relatively uncommon in Australia, where the age-standardised incidence is 23% lower than estimated worldwide (Ferlay et al., 2004;AIHW, 2008). The proportional contribution of laryngeal cancer to the incidence of invasive cancers of all sites in Australia is 0.6%, which is much lower than the 1.5% estimated worldwide. There was a high male to female ratio of age-standardised incidence rates of 9.0 to one in 2004, which was similar to the estimated 8.5 to one applying worldwide. It is thought that higher use of tobacco and alcohol would be a major factor in the elevated incidence in males (Austin et al., 1996; Cattaruzza et al., 1996; Boffetta et al., 2002).

Tobacco smoking is an important cause of laryngeal cancer and shows a strong dose-response relationship (Austin et al., 1996; Cattaruzza et al., 1996; Boffetta et al., 2002). In Australia about 70% of laryngeal cancers are attributed fully or in part to smoking (AIHW, 2004). This compares with a figure of about 82% for lung cancer. Secular incidence trends have varied, however, with the incidence of laryngeal cancer reducing by about 35% in both males and females since the early 1980s, but with contrasting trends for lung cancer of a 28% reduction in males and a 63% increase in females (AIHW, 2008). Alcohol is thought to be a factor in about half of laryngeal cancers in Australia and is known to have a synergistic effect with tobacco smoking (Austin et al., 1996; Cattaruzza et al., 1996; Boffetta et al., 2002; AIHW, 2004). While alcohol consumption likely would have affected the secular trends for laryngeal cancer, it is not clear why lung and laryngeal cancer incidence trends have been so divergent in females. In that some researchers have proposed that nutritional or even hormonal factors may affect the risk of laryngeal cancer (Cattaruzza et al., 1996; Riboli et al., 1996; IARC, 1999; Gallus et al., 2003), it is possible that these factors may have influenced secular trends.

Survivals for laryngeal cancer have not been presented for Australia as a whole. However, figures at a state level show similar 5-year survivals to the USA SEER figure of around 64% (Youlden et al., 2005; English et al., 2007; Threlfall et al., 2000; SACR, 2000; Ries et al., 2008).

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Notably SEER data have not shown survival gains since the 1970s, despite an increase in proportion of these cancers being assigned to the glottis where five-year survivals are higher at around 81% compared with the 48% figure for cancers of the supra-glottis and sub-glottis (Ries et al., 2007). Similar evidence of little change in survival has been reported in Finland (Teppo et al., 2001), and five-year survivals have also been largely unchanged in England and Wales since the early 1980s, although earlier increases were reported (Cancer Research UK, 2007). An unusual feature of the USA data has been a tendency for lower five-year survivals of 59% in females, compared with the 65% for males, despite similar stage distributions (Ries et al., 2008).

In this study, we investigate trends in incidence, mortality and survival for laryngeal cancer in an Australian population, and differences in survival by sex, other socio-demographic characteristics, and laryngeal sub-site, using data from the South Australian Cancer Registry. Possible explanations for observed trends are considered and research and cancer-control implications are discussed.

Materials and Methods

Data collection

The South Australian Cancer Registry has received statutory notifications of invasive laryngeal cancers from hospitals, laboratories and radiotherapy centres since 1977 (SACR, 2000; SA Dept Hlth, 2007). The Registry 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).

The present study included 1,273 invasive laryngeal cancers (ICDO3: C32), diagnosed between 1977 and 2005. Since there were few cancers of the sub-glottis (SACR, 2000), laryngeal cancers were broadly classified by sub-site as glottis or other. Since the great majority of these cancers were squamous cell and related carcinomas (SACR, 2000), they were not classified by histological type in this study. Socio-demographic descriptors included age at diagnosis; sex; region of residence, classified as 20 statistical sub-divisions and categorised as metropolitan or non-metropolitan (SACR, 2000); country of birth (expressed using World Health Organization criteria) (Ferlay et al., 2004); and relative socio-economic disadvantage, as inferred from residential postcode characteristics using the SEIFA index (a socio-economic index for areas) expressed as four ordinal categories (ABS, 1998).

Statistical analyses

A de-identified file was extracted and analysed in-house under provisions of the South Australian Health Commission Act, using STATA 9.2 software (StataCorp., 2005).

Mean annual incidence and mortality rates were determined for successive diagnostic periods from 1977 to 2005, directly standardising by five-year age group (open-ended category from 85 years) to the 2001 Australian reference population (StataCorp, 2005; Armitage et al., 1987). Ninety-five per cent confidence limits were calculated assuming a Poisson distribution, as described previously (Dobson et al., 1991). Rates were calculated for all ages combined and summarised for age categories under 50, 50-69, and 70 years or more respectively, to assist a visualisation of trends. A review of secular trends for five-year age groups within these broad categories indicated that there were not differences that were masked by these age aggregations.

Differences in epidemiological characteristics of laryngeal and other invasive cancers were investigated, plus differences between glottis and other laryngeal sub-sites. Initially each characteristic was analysed as a univariate predictor, using the Pearson chi-square test for nominal variables and the Mann-Whitney U test for ordinal variables (StataCorp, 2005; Armitage et al., 1987). Epidemiological differences were further explored using multiple logistic regression analysis. All socio-demographic variables were entered as predictors, with backwards elimination of those where the fit of the model did not reduce as a consequence ($p>0.05$). Assumptions underlying this analysis, including an absence of co-linearity, were found to be satisfied.

Case survivals were calculated, with a date of censoring of live cases of December 31st, 2005. Kaplan-Meier product-limit estimates of disease-specific survival were calculated, treating deaths from other causes and people still alive at the end of 2005 as censored observations (StataCorp, 2005; Armitage et al., 1987).

Multivariable Cox proportional hazards regression also was undertaken to assess socio-demographic and histological predictors of survival from laryngeal cancer (StataCorp, 2005; Armitage et al., 1987). The censoring criteria were the same in the regression analysis as for the Kaplan-Meier analyses. All socio-demographic variables, period of diagnosis, and laryngeal sub-site were entered into the analysis, with backwards elimination, as described for the logistic regression. Assumptions underlying the analysis, including proportionality and an absence of co-linearity, were found to be satisfied.

Disease-specific survival was preferred to relative survival or other excess mortality methods because life tables were not available for all sub-groups. Analyses have shown very similar survival estimates in South Australia, irrespective of whether relative survivals or disease-specific survivals were used (SACR, 1997).

Results

Age-standardised incidence and mortality trends

A reduction in incidence of 31.6% was evident for both sexes combined between 1977-84 and 1995-2005, with the indication of a continuing decline during 1995-2005 (Table 1). The mean annual incidence (95% confidence limits) per 100,000 people declined from 3.8

Table 1. Mean Annual Age-standardised (Australia, 2001) Incidence and Mortality Rates (95% confidence limits) for Laryngeal Cancer per 100,000 South Australians by Sex and Calendar Year Period*

Year		1977-84	1985-94	1995-2005	(1995-99)	(2000-05)	Total
Incidence	Males	n=298	n=439	n=398	n=188	n=210	n=1,135
		6.6 [5.9, 7.4]	6.8 [6.2, 7.4]	4.8 [4.3, 5.2]	5.2 [4.5, 6.0]	4.4 [3.8, 5.0]	5.9 [5.6, 6.3]
	Females	n=44	n=42	n=52	n=22	n=30	n=138
		0.9 [0.6, 1.2]	0.6 [0.4, 0.8]	0.5 [0.4, 0.7]	0.5 [0.3, 0.8]	0.5 [0.4, 0.8]	0.6 [0.5, 0.7]
	Total	n=342	n=481	n=450	n=210	n=240	n=1,273
		3.8 [3.4, 4.2]	3.7 [3.4, 4.0]	2.6 [2.4, 2.9]	2.9 [2.5, 3.3]	2.5 [2.2, 2.8]	3.3 [3.1, 3.5]
Mortality	Males	n=95	n=127	n=159	n=81	n=78	n=381
		2.2 [1.8, 2.7]	1.9 [1.6, 2.3]	2.0 [1.7, 2.3]	2.4 [1.9, 3.0]	1.7 [1.3, 2.1]	2.1 [1.9, 2.3]
	Females	n=13	n=18	n=14	n=7	n=7	n=45
		0.3 [0.2, 0.5]	0.2 [0.1, 0.4]	0.1 [0.1, 0.2]	0.2 [0.1, 0.3]	0.1 [0.0, 0.2]	0.2 [0.2, 0.3]
	Total	n=108	n=145	n=173	n=88	n=85	n=426
		1.2 [1.0, 1.5]	1.1 [0.9, 1.3]	1.1 [0.9, 1.2]	1.3 [1.0, 1.6]	0.9 [0.7, 1.1]	1.1 [1.0, 1.3]

*Data source: South Australian Cancer Registry

Table 2. Mean Annual Age-standardised (Australia, 2001) Incidence Rates (95% confidence limits) for Laryngeal Cancer per 100,000 South Australians by Age, Sex and Calendar Year Period*

Year		1977-84		1985-94		1995-2005		Total	
Males	0-49	n=20	0.7 [0.4, 1.1]	n=21	0.5 [0.3, 0.7]	n=31	0.5 [0.4, 0.7]	n=72	0.5 [0.4, 0.7]
	50-69	n=211	20.7 [18.0, 23.7]	n=267	19.0 [16.8, 21.4]	n=177	10.4 [8.9, 12.1]	n=655	15.9 [14.7, 17.2]
	70+	n=67	22.8 [17.7, 29.0]	n=151	29.8 [25.2, 35.0]	n=190	25.7 [22.2, 29.7]	n=408	26.6 [24.1, 29.4]
Females	0-49	n=4	0.1 [0.0, 0.4]	n=3	0.1 [0.0, 0.2]	n=4	0.1 [0.0, 0.2]	n=11	0.1 [0.0, 0.2]
	50-69	n=27	2.6 [1.7, 3.7]	n=23	1.6 [1.0, 2.4]	n=26	1.5 [1.0, 2.2]	n=76	1.8 [1.4, 2.2]
	70+	n=13	3.0 [1.6, 5.1]	n=16	2.3 [1.3, 3.7]	n=22	2.2 [1.4, 3.3]	n=51	2.4 [1.8, 3.1]
Total	0-49	n=24	0.4 [0.3, 0.6]	n=24	0.3 [0.2, 0.4]	n=35	0.3 [0.2, 0.4]	n=83	0.3 [0.3, 0.4]
	50-69	n=238	11.6 [10.2, 13.2]	n=290	10.3 [9.1, 11.5]	n=203	6.0 [5.2, 6.8]	n=731	8.8 [8.2, 9.5]
	70+	n=80	12.9 [10.2, 16.1]	n=167	16.0 [13.7, 18.7]	n=212	14.0 12.1, 16.0]	n=459	14.5 [13.2, 15.9]

*Data source: South Australian Cancer Registry

(3.4, 4.2) in 1977-84 to 2.6 (2.4, 2.9) in 1995-2005, with a decline apparent in both sexes. Even in females where there were overlapping confidence limits of mean annual rates for 1977-84 and 1995-2005, the secular decline by calendar year was significant ($p=0.037$). While corresponding downward trends in mortality rates also were suggested, they did not achieve statistical significance with the smaller numbers of cases available for analysis ($p>0.05$).

Incidence reductions were evident in both sexes combined in the age range under 70 years. In 50-69 year olds, a 48.3% reduction was evident between 1977-84 and 1995-2005, in that the mean annual incidence per 100,000 reduced from 11.6 (10.2, 13.2) to 6.0 (5.2, 6.8) (Table 2). Similar declines were suggested in males and females in this age range. However, the decline by calendar year period in females, while approaching statistical significance, was not statistically significant ($p=0.088$). By comparison, a reduction in incidence was not suggested for both sexes combined for the age range of 70 years and over and the trends apparent by sex were not consistent (Table 2).

Proportional contribution to all cancers

Overall, 0.7% of all invasive cancers had a primary site of larynx, with this proportion ranging from 1.0% in 1977-79 to 0.5% in 2000-5. Univariate analyses indicated that compared with other invasive cancers, laryngeal cancers differed by age at diagnosis ($p=0.021$), sex ($p<0.001$), socio-economic status ($p<0.001$), country of birth ($p<0.001$, and diagnostic year ($p<0.001$), but not by place of residence ($p=0.938$). Multiple logistic regression indicated that the proportion of cancers with a primary site of larynx was higher among: 50-69 and (less so) 70-79 year olds than younger or older cases; males than females; cases born in UK/Ireland and male cases born in Southern Europe than other cases; lower socio-economic cases; and cases diagnosed in the earlier years between 1977 and 1989 (Table 3). Similar socio-demographic trends applied by sex, except for the excess proportion of laryngeal cancers in cases born in Southern Europe, which applied to males only.

Proportional contribution of glottis to all laryngeal cancers

Overall 59.9% of laryngeal cancers had a sub-site of glottis, with this proportion increasing from 41.9% in 1977-79 to 50.2% in 1980-84, 57.8% in 1985-89, 63.0% in 1990-94, 68.6% in 1995-99, and 68.8% in 2000-05, and with increases applying to both males ($p<0.001$) and females ($p=0.025$). Bivariate analyses indicated that cancers of the glottis differed from other laryngeal cancers by age at diagnosis ($p=0.002$), sex ($p<0.001$), country of birth ($p=0.004$), and diagnostic year ($p<0.001$), but not by place of residence ($p=0.276$) or socio-economic status ($p=0.349$). Multiple logistic regression analysis indicated that the proportion of laryngeal cancers with a primary sub-site of glottis was higher: after age 70 years; in males; in cases born in Southern Europe, UK/Ireland and Western Europe; and in later diagnostic periods (Table 4).

Table 3. Relative Odds (95% confidence limits) of Laryngeal Cancer Compared with Other Cancers in South Australia by Age, Sex, Year of Diagnosis, Socio-economic Status, and Country of Birth*

		Males	Females	Total
Age (yrs.):	<50 (ref) [n=25,612]	1.00	1.00	1.00
	50-59 [n=26,700]	2.69 [2.06, 3.51]	3.12 [1.57, 6.22]	2.77 [2.16, 3.54]
	60-69 [n=43,578]	2.28 [1.77, 2.93]	3.31 [1.71, 6.41]	2.41 [1.90, 3.05]
	70-79 [n=49,149]	1.66 [1.28, 2.14]	2.68 [1.37, 5.26]	1.77 [1.39, 2.25]
	≥80 [n=27,846]	0.88 [0.64, 1.21]	1.40 [0.63, 3.14]	0.94 [0.70, 1.27]
Sex:	Male (ref) [n=94,188]	--	--	1.00
	Female [n=78,697]	--	--	0.15 [0.13, 0.18]
Diagnosis year:	1977-89 (ref) [n=56,805]	1.00	1.00	1.00
	1990-94 [n=31,631]	0.73 [0.62, 0.86]	0.50 [0.30, 0.85]	0.71 [0.61, 0.83]
	1995-99 [n=36,288]	0.57 [0.48, 0.67]	0.54 [0.33, 0.87]	0.57 [0.48, 0.66]
	2000-05 [n=48,161]	0.48 [0.41, 0.57]	0.56 [0.36, 0.87]	0.49 [0.42, 0.57]
Socio-economic status**:				
	Low/mid-low (ref) [n=84,735]	1.00	1.00	1.00
	Mid-high [n=45,555]	0.79 [0.69, 0.91]	0.62 [0.41, 0.96]	0.77 [0.67, 0.88]
	High [n=42,595]	0.70 [0.59, 0.82]	0.53 [0.34, 0.85]	0.68 [0.58, 0.79]
Country of birth:	Other (ref) [n=139,246]	1.00	1.00	1.00
	Southern Europe [n=9,585]	1.62 [1.33, 1.98]	0.34 [0.08, 1.37]	1.52 [1.26, 1.85]
	UK/Ireland [n=24, 054]	1.21 [1.04, 1.43]	1.89 1.28, 2.78]	1.29 [1.11, 1.50]

*Multivariable logistic regression analysis (see methods)**As indicated by SEIFA index (see methods)
*Data source: South Australian Cancer Registry

Table 4. Relative Odds (95% CL) of Glottic as Compared with other Laryngeal Cancers by Age, Sex, Country of Birth and Year of Diagnosis*

	Category	Relative odds
Age (yrs.):	<70 (ref) [n=810]	1.00
	70-79 [n=366]	1.35 [1.03, 1.76]
	80+ [n=97]	1.54 [0.96, 2.45]
Sex:	Male (ref) [n=1,135]	1.00
	Female [n=138]	0.38 [0.26, 0.55]
Country of birth:	Other (ref) [n=887]	1.00
	South Europe [n=118]	1.54 [1.01, 2.35]
	UK/Ireland [n=226]	1.37 [1.00, 1.88]
	West Europe [n=42]	1.89 [0.94, 3.79]
Diagnosis year:	1977-79 (ref) [n=105]	1.00
	1980-84 [n=237]	1.48 [0.92, 2.38]
	1985-89 [n=251]	1.91 [1.19, 3.05]
	1990-94 [n=230]	2.21 [1.37, 3.57]
	1995-99 [n=210]	2.87 [1.75, 4.70]
	2000-05 [n=240]	2.92 [1.80, 4.74]

*Multivariable logistic regression analysis (see text)

Table 5. Relative Risk (95% CL) of Death from Laryngeal Cancer among Patients Classified by Age, Place of Residence, Country of Birth, and Whether Glottic or other Laryngeal Sub-site of Primary Cancer*

	Category	Relative odds
Age (yrs.):	<60 (ref) [n=359]	1.00
	60-69 [n=451]	1.37 [1.06, 1.78]
	70-79 [n=366]	1.57 [1.19, 2.07]
	≥80 [n=97]	3.81 [2.60, 5.58]
Residence:	Metropolitan (ref) [n=945]	1.00
	Country area [n=328]	1.33 [1.07, 1.65]
Country of birth:	Other (ref) [n=1,155]	1.00
	South Europe [n=118]	0.59 [0.39, 0.90]
Sub-site:		
	Glottis (ref) [n=762]	1.00
	Other [n=511]	2.78 [2.26, 3.41]

*Multivariable proportional hazards regression analysis (see text)

Survivals

The five-year survival from laryngeal cancer (95% confidence limits) was 68.2 (65.5, 70.9)%. Differences in survival were indicated for the following univariate predictors: age at diagnosis (p<0.001), with survival reducing from 74.2% in cases under 50 years to 48.2% in those aged 80 years or more; country of birth (p<0.001), with patients born in Southern Europe having a 82.1% survival compared with 66.7% for other cases; place of residence (p=0.007), with metropolitan cases having a 70.1% survival compared with a 62.6% figure for non-metropolitan cases; and sub-site of cancer (p<0.001), with glottis cases having a 77.6% survival compared with 54.1% for other sub-sites. There was not a significant difference by sex (p=0.558), the five-year survival being 67.6% for males and 73.1% for females. Similarly differences were not found by diagnostic period (p=0.326) or socio-economic status (p=0.095). Multiple proportional hazards regression analysis indicated that risks of case fatality from laryngeal cancer were higher in older cases and those who were resident in country areas (Table 5). By comparison, lower risks of death were indicated for cases born in Southern Europe and those with a primary sub-site of glottis rather than another sub-site.

Discussion

The secular reduction in incidence observed in this study was broadly consistent with the national trends (AIHW, 2008). While there was less evidence of a downward trend in mortality than incidence, numbers of deaths were small, particularly in females, such that the statistical power available to show differences was limited. The downward trend in incidence for both sexes combined applied to the age range under 70 years. Hopefully it reflects a cohort effect that will extend in time to the older age groups.

The decrease in incidence for males is consistent with the trend for lung cancer and historic smoking trends, whereas the decrease in females runs counter to the upward trend for lung cancer and indicates that factors other than smoking would be involved (Ferlay et al., 2004; CCCR, 2002). Compared with males, females had a higher proportion of laryngeal cancers of non-glottis sub-sites where alcohol consumption is likely to play a larger role (Austin et al., 1996; Boffetta et al., 2002). It is possible that decreases in alcohol consumption have contributed to reductions in risk of laryngeal cancer in both sexes, both directly and by reducing opportunities for a synergistic effect with tobacco smoking (Austin et al., 1996; Cattaruzza et al., 1996; Boffetta et al., 2002; ABS, 2000).

Early Australian data indicate that secular trends in laryngeal cancer are more closely correlated with trends in alcohol than tobacco consumption (McMichael, 1979). It is relevant therefore that data from the Australian Bureau of Statistics indicate that per capita alcohol consumption reduced by approximately 22% between the late 1970s and 1998-99 (ABS, 2000). In that cancers of the glottis are thought to be less closely related to alcohol consumption than those of the supra-glottis (Austin et al., 1996; Boffetta et al., 2002), it is possible that decreases in alcohol consumption have contributed to the increased proportion of glottis cancers.

The male to female ratio of age-standardised laryngeal cancer incidence in this study of 9.8 to one is broadly consistent with national and world-wide ratios and is largely attributable to the higher consumption of tobacco and alcohol by males (Ferlay et al., 2004; AIHW, 2008; Austin et al., 1996; Gallus et al., 20003; ABS, 2000). However, it is also possible that occupational exposures may have contributed, including exposures to wood dust, paint fumes, soot and coal dust, and potentially formaldehyde, nickel, isopropyl alcohol, sulphuric acid mist and diesel fumes (Austin et al., 1996; Boffetta et al., 2002; CCCR, 2002). Meanwhile the higher proportion of glottis than other laryngeal cancers in males than females may reflect a stronger relative contribution of tobacco consumption as opposed to alcohol consumption to male than female cases (Austin et al., 1996; Boffetta et al., 2002; Tuyns et al., 1988).

Overall, 0.5% all invasive cancers diagnosed in 2000-05 in this study had a primary site of larynx, which is similar to the national figure of 0.6% for 2000-04 (AIHW, 2008). More than other invasive cancers, laryngeal cancers predominate in males, lower socio-economic areas, males and females born in UK/Ireland, and males born in Southern Europe. It is likely from the excess in lung cancer in these sectors of the population that tobacco smoking has been an important contributor (CCCR 2002; Roder, 2000). It is also possible from the higher contribution of glottis than other laryngeal sub-sites to laryngeal cancers in males and cases born in Southern Europe and UK/Ireland that the relative contribution of alcohol consumption as opposed to tobacco smoking has been lower for these groups (Austin et al., 1996; Boffetta et al., 2002; Tuyns et al., 1988). Overall, the percentage of laryngeal cancers with a glottis sub-site was similar to that seen in the USA, in that the SEER figure of 61.2% for 1988-2001 was only slightly lower than the 62.8% reported in this study for 1985-1999 (Ries et al., 2007).

As seen in the USA, Finland and since the early 1980s, in the United Kingdom, secular trends in case survivals were not found in this study, although improvements may have been expected due to the increased proportion of glottis cases where survivals were higher (Ries et al., 2008; Teppo et al., 2001; Cancer Research UK, 2007). Survivals in South Australia were similar to those reported by other Australian states and the USA, although the deficit apparent for females in the USA was not observed (Ries et al., 2008). While around 68% of cases were found to have survived their cancer for five years or more in this study, which compares favourably with survivals for most other cancers, further research is indicated to increase this figure. Particular attention should be given to older cases where poorer outcomes apply.

The higher case-fatality rates for non-metropolitan than metropolitan patients also warrant attention. Radiotherapy plays a central role in the treatment of these cancers and previous research has shown that non-metropolitan patients are less likely to receive radiotherapy for cancers of equivalent organ site than their metropolitan counterparts (SACR, 2000; Luke et al., 2003). In addition, it is possible that later stages applied at presentation for non-metropolitan cases partly due to poorer access to ENT specialists. Stage is not collected by the State Registry, however, and the possibility of stage differences needs separate investigation.

The better survivals observed for laryngeal cancer cases born in Southern Europe also requires further study. This result was confirmed after adjusting for age, place of residence and cancer sub-site. Elevations in cancer survival have been reported for cases born in Southern Europe in other Australian studies, where the possibility of artificial effects from death under-ascertainment has been raised (Tracey et al., in press).The suggestion has been made that that some terminal cases may return to their countries of birth to die, such that their deaths are not notified to Australian cancer registries. However, patients born in other countries did not show a similar elevation in survival in this study. Another possibility is that dietary factors, differences in tumour biology or other undisclosed factors may have contributed to real elevations in survival for cases born in Southern Europe.

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