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Impact of Stage-Specific Guideline Concordant Treatment in Small Cell Lung Cancer in Victoria, Australia

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ABSTRACT

Introduction: Lung cancer accounts for 9% of all cancer diagnoses in Australia with a 5-year survival rate of 26%. Small cell lung cancer (SCLC) is a more aggressive subtype of lung cancer, representing 15% of all lung cancer cases and a 5-year survival of 11.1%. This study aims to assess the extent of guideline concordant treatment (GCT) delivery for SCLC in Victoria, identify patient, clinical, and hospital factors influencing GCT receipt, and evaluate its impact on survival.

Methods: Data were obtained from the Victorian Lung Cancer Registry (VLCR) in Victoria, Australia ($n = 1769$). Descriptive statistics were used to summarie patient and disease characteristics by treatment type, including GCT, non-GCT, and no/declined treatment. Statistical analyses included multiple logistic regression, Cox regression, and Kaplan–Meier survival estimates.

Results: 78.1% received GCT, 10.5% received non-GCT, and 11.5% had no treatment. Older age, poor performance status, and advanced cancer stage were associated with a lower likelihood of receiving GCT. Patients who received stage-specific GCT had a 60% lower mortality risk compared to those who received non-GCT treatment.

Conclusion: This study highlights significant variation in the receipt of guideline concordant treatment for SCLC, with older age, poorer performance status, and advanced cancer stage reducing the likelihood of GCT. Given the survival benefits associated with GCT, addressing barriers to its delivery is essential to improving outcomes for SCLC patients in Victoria.

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1 | Introduction

In Australia, lung cancer accounts for 9% of all cancer diagnoses, and in 2022, it contributed to the leading cause of all cancer deaths at 17% [1, 2]. Lung cancer has one of the lowest 5-year survival rates among all cancers at 26% [3]. Small cell lung cancer (SCLC) accounts for 15% of all lung cancer cases and is considered the most aggressive form of lung cancer, with a median survival time of 7.2 months and a 5-year survival rate of 11.1% [4, 5]. SCLC for this study was staged as either limited (LS-SCLC Stage I-III) or extensive stage (ES-SCLC Stage IV) [6].

A seminal 1998 research and development study identified the delivery of guideline-concordant treatment (GCT) to just half of all patients (54.9%), across screening and prevention, management of acute or chronic conditions, and follow-up representing a substantial healthcare evidence-practice gap [7, 8]. This failure of knowledge translation reflects a significant evidence-to-practice gap, suboptimal care, and the risk of healthcare system disparity and inequity [5].

Clinical practice guidelines for treatment of SCLC have been published internationally and are available to clinicians to encourage evidence-based clinical decision making and reduce unwarranted variation in lung cancer care [5, 9]. Adherence to clinical practice guidelines serves as a key indicator of the adoption and integration of best evidence-based practices. It helps to assess unwarranted variation and provides insights into equity and variations in care for disadvantaged groups [10].

Studies focused on guideline treatment have predominantly been completed in patients with non-small cell lung cancer, finding that patients receiving GCT have improved survival [11–13]. Identified barriers to receipt of GCT include higher age, ethnicity, socioeconomic status, and regional location of residence [12–15]. There is little evidence to confirm the extent to which SCLC patients receive GCT, and which patient, clinical, or hospital characteristics can affect the likelihood of receiving GCT and impacts of GCT on survival.

We sought to explore the extent of delivery of GCT to patients newly diagnosed with SCLC in Victoria, which is Australia's second most populous state (population > 7 million [16]) and to investigate which patient, disease, and management characteristics may affect the likelihood of delivery of GCT and to determine the impacts of GCT on overall survival.

2 | Methods

2.1 | Study Design and Population

This prospective cohort study was conducted in Victoria, Australia using data from the Victorian Lung Cancer Registry (VLCR), a population-based clinical quality registry. The VLCR has registered 1769 SCLC patients with data collected on demographic, clinical, and treatment information between 8th July 2011 and 5th May 2023 [17].

2.2 | Dataset and Consent

Established in 2011, the VLCR captures information from 19 healthcare networks, encompassing over 50 metropolitan and regional hospitals [17]. The aim of the VLCR is to collect, analyze, and report information about the care and outcomes being delivered by health service organizations and serve as a tool for the evaluation of improvement in the safety and quality of care provided to Australian consumers [18–20].

2.3 | Data Collection and Validation

Data capture is accomplished by passive download from health information services (HIS), and supported actively by a data collector with access to medical records and clinician notes. The database has a comprehensive data dictionary and an in-built validation capacity in order to minimize data entry. Information collected includes data on diagnosis, management, and treatment. Patients are included in the registry if they are 18 years and older with newly diagnosed lung cancer initially identified through hospital coding (ICD-10 codes: C34 0–C34 9, Z85 1, Z85 2) and subsequently screened for eligibility by trained data collectors. While most patients have a histologically confirmed diagnosis, inclusion is also permitted based on cytology or clinical imaging evidence. Patients presenting with a lung cancer diagnosis in the last 5 years, a secondary lung cancer diagnosis, or if they have chosen to opt out of consent to the registry were excluded.

2.4 | Data Variables

The primary endpoint for this study was overall survival, defined from a person's date of diagnosis of lung cancer to the date of death or census date on 28th September 2023. Multiple sources are used to confirm a death date for patients, with the primary source being from the Victorian Registry of Births, Deaths, and Marriages [21].

2.4.1 | Demographic Variables

Age, gender, indigenous status, regionality of residence (metropolitan/rural), preferred language, and country of birth were collected. Country of birth was categorized into either born overseas or those born in Australia. Socioeconomic status (SES) was ranked low, medium, and high based on the Index of Relative Socio-Economic Advantage and Disadvantage (IRSAD) deciles with a category for 'other' for patients residing out of Victoria [22].

2.4.2 | Clinical and Treatment Variables

Patients were categorized into LS-SCLC (Stage I-III) and ES-SCLC (Stage IV) and stage missing according to tumor, node, and metastasis (TNM) staging [23]. Treatment type was categorized into three categories: GCT, non-GCT, and no treatment according to the treatment guidelines for SCLC, Table S1 [14].

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GCT has been defined as the minimal first-line stage-specific treatment lung cancer patients should receive according to the National Comprehensive Cancer Network Guidelines [9, 14]. Treatment not in concordance with guidelines (non-GCT) was defined as treatments or combinations of treatments that did not include the minimum GCT recommendations. There was also insufficient data to determine whether combinations of treatments were delivered sequentially or concurrently. Radiotherapy dosing and fractionation were unavailable.

Smoking status was defined as never, current, and ex-smoker. Comorbidities included diabetes, renal insufficiency, myocardial infarction, respiratory comorbidity, and neoplastic comorbidity. A patient was considered to have diabetes if they received oral hypoglycaemics or insulin, renal insufficiency if serum creatinine $>200\,\mu$mol/L or dialysis-dependent, and myocardial infarction if a patient had a history of myocardial infarction or coronary intervention including coronary artery stents, angioplasty, and coronary artery bypass grafts. A patient was considered to have a respiratory comorbidity if forced expiratory volume $<66\%$, neoplastic comorbidity if there was a past history of cancer other than lung cancer, and weight loss if any weight loss was documented. The Eastern Cooperative Oncology Group (ECOG) scale was used to describe functional performance status (PS) [24, 25]. The scores are based on a patient's ability to perform daily activities and capability of self-care. ECOG scores were categorized as <2 (considered good PS) or ≥ 2 (considered poor PS) [26].

2.4.3 | Management Variables

Clinical management variables included psychosocial distress screening and discussion at a multidisciplinary meeting (MDM). Timeliness variables included the date of referral for lung cancer evaluation, the date of diagnosis, and the date of first treatment. This enabled a description of the referral to diagnosis interval (standard <28 days) and the diagnosis to treatment interval (<14 days) [17, 27]. Hospitals were categorized into public metropolitan, private metropolitan, or public inner regional hospitals.

2.5 | Statistical Analysis

Mean and standard deviation were used for descriptive statistics for numerical data, and percentages for categorical data. ANOVA and chi-squared methods were used for univariate analysis. Statistical precision was improved as missing data was imputed through the multiple imputation by chained equations method with 20 imputations, Table S2. Survival analysis was completed using Kaplan–Meier estimates of survival and log-rank statistic. A multivariable logistic regression was performed to identify factors that influenced the likelihood of receiving GCT, and a multivariable COX regression was performed to determine factors that influenced overall survival. Variables with a p value of 0.05 or less in the univariable analysis were included in the multivariable models. Model discrimination was assessed by the c-statistic (area under the receiver operating characteristic [ROC]) curve. Landmark analyses were completed for all multivariable models by excluding patients that died within 28 days of diagnosis as death is likely to be an early confounder for patients receiving non-GCT. All statistical analysis was completed in Stata, version 15 (StataCorp, College Station, Tex, USA).

2.6 | Ethics Approval

Ethics approval was obtained from the Monash University Human Research Ethics Committee (#29731). Ethics approval for the development of the VLCR has been previously described and obtained from the Alfred Health Ethics Committee as well as all participating hospitals [17].

3 | Results

3.1 | Patient, Cancer and Comorbidities

The VLCR registered 16491 participants between July 2011 and March 2023, 10.7% ($n=1769$) diagnosed with SCLC, among whom 78.1% were treated with GCT, 10.5% received non-GCT, and 11.5% had no recorded treatment, Table 1. Among patients who had SCLC, 7.8% ($n=138$) had staging missing; therefore, they were not considered for categorization for GCT or non-GCT. Patients who received GCT compared to non-GCT patients tended to be slightly younger (67.3 years vs. 72.5), reside in metropolitan Victoria (64% vs. 61.8%) and were more likely born in Australia (67.1% vs. 60.7%). GCT-treated patients were more likely to be male (58.1%). SES status was similar across treatment groups. The number of former smokers was lower in the GCT group compared to non-GCT (43.7% vs. 53.5%) but there was a slightly higher number of current smokers (54.1% vs. 45.3%). GCT-treated patients were less likely to have renal insufficiency (1.3% vs. 5.5), respiratory comorbidity (22.5% vs. 28.7%) and have an ECOG performance score of less than 2 (77.7% vs. 61.7%) compared to non-GCT, (Table 1).

3.2 | Management and Treatment

A significantly lower number of patients receiving GCT were discussed at an MDM (57.5% vs. 69.6%), Table 1. Non-GCT treated patients were significantly less likely to be screened for psycho-social supportive care needs (37.4% vs. 44.2%), $p<0.001$ and to be treated in a public metropolitan hospital (67.8% vs. 73.3%, $p<0.001$) compared to GCT-treated patients. A significantly higher proportion of GCT-treated patients were diagnosed within 28 days from referral (83.7% vs. 72.6%), and received treatment within 14 days or less of diagnosis (76.1% vs. 62.8%). Patients with ES-SCLC living in either metropolitan or rural Victoria were more likely to have a referral to diagnosis within 28 days compared to patients with LS-SCLC, Figure S1. This trend was also seen for diagnosis to treatment times, where patients with ES-SCLC were more likely to be treated within 14 days compared to patients with LS-SCLC. Among patients with LS-SCLC, 43% of patients living in rural Victoria experienced diagnosis to treatment delays greater than 14 days compared to those living in metropolitan Victoria (35.5%). Only 22.7% of patients with ES-SCLC experienced a delay from diagnosis to treatment, Figure S1.

A majority of LS-SCLC patients receiving GCT had a combination of SACT and radiotherapy (64.6%), while the highest proportion of

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TABLE 1 | Baseline characteristics for patients with SCLC by treatment type ($n = 1631$).

	GCT *n* (%)	Non-GCT *n* (%)	No treatment *n* (%)	*p*
Patient characteristics				
Number of patients	1273 (78.05)	171 (10.48)	187 (11.47)	
Age Mean ± SD (years)	67.26 ± 9.74	72.52 ± 8.48	74.25 ± 9.85	0.061
Sex				0.156
Female	533 (41.87)	84 (49.12)	75 (40.11)	
Male	740 (58.13)	87 (50.88)	112 (59.89)	
Indigenous Australian	15 (1.18)	2 (1.18)	2 (1.08)	0.993
Country of birth				0.022
Australia	846 (67.14)	102 (60.71)	107 (58.15)	
Overseas	414 (32.86)	66 (39.29)	77 (41.85)	
English as preferred language	1174 (92.66)	157 (91.81)	163 (87.17)	0.036
Regionality of residence (ref: metro)				0.146
Metropolitan Victoria	815 (64.02)	105 (61.76)	129 (68.98)	
Rural Victoria	425 (33.39)	59 (34.71)	58 (31.02)	
Other Australian states	33 (2.59)	6 (3.53)	0 (0)	
Socio-economic status[a]				0.311
Low	283 (22.82)	47 (28.66)	50 (26.74)	
Medium	517 (41.69)	58 (35.37)	77 (41.18)	
High	440 (35.48)	59 (35.98)	60 (32.09)	
Smoking status				0.136
Never smoked	27 (2.15)	2 (1.18)	2 (1.14)	
Ex-smoker	548 (43.74)	91 (53.53)	83 (47.16)	
Current smoker	678 (54.11)	77 (45.29)	91 (51.70)	
Comorbidities				
Diabetes	267 (20.97)	40 (23.39)	42 (22.46)	0.717
Renal insufficiency	16 (1.30)	9 (5.45)	16 (9.04)	< 0.001
Myocardial comorbidity	207 (16.26)	34 (19.88)	30 (16.04)	0.478
Respiratory comorbidity	286 (22.47)	49 (28.65)	48 (25.67)	0.151
Neoplastic comorbidity	197 (15.48)	33 (19.30)	35 (18.72)	0.277
ECOG status				< 0.001
Score 0–1	708 (77.72)	74 (61.67)	29 (28.71)	
Score ≥ 2	203 (22.28)	46 (38.33)	72 (71.29)	
Experienced weight loss	563 (58.71)	69 (51.11)	91 (72.22)	0.002
Cancer characteristics				
Cancer stage				< 0.001
Limited disease stage	325 (25.53)	130 (76.02)	25 (13.37)	
Extensive disease stage	948 (74.47)	41 (23.98)	162 (86.63)	
Cancer management				

(Continues)

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TABLE 1 | (Continued)

	GCT *n* (%)	Non-GCT *n* (%)	No treatment *n* (%)	*p*
Discussed at MDM[b]	732 (57.50)	119 (69.59)	70 (37.43)	< 0.001
Psychosocial distress screening completed	562 (44.22)	64 (37.43)	16 (8.60)	< 0.001
Referral to diagnosis				0.001
≤ 28 days	995 (83.68)	114 (72.61)	153 (87.43)	
> 28 days	194 (16.32)	43 (27.39)	22 (12.57)	
Diagnosis to treatment				0.001
≤ 14 days	960 (76.07)	103 (62.80)	6 (75.00)	
> 14 days	302 (23.93)	61 (37.20)	2 (25.00)	
Death within 28 days of diagnosis	47 (3.69)	8 (4.68)	96 (51.34)	< 0.001
Hospital characteristics				
Treating hospital regionality (ref: public metro hospital)				0.039
Public metropolitan hospital	933 (73.29)	116 (67.84)	141 (75.40)	
Private metropolitan hospital	111 (8.72)	31 (18.13)	15 (8.02)	
Inner regional public hospital	229 (17.99)	24 (14.04)	31 (16.58)	

[a]Low = IRSAD decile 1 to 3, Medium = IRSAD decile 4 to 7, High = IRSAD decile 8 to 10.
[b]Multidisciplinary meeting.

non-GCT treated patients received SACT (18.8%) or radiotherapy (5.4%), (Table S3). Patients with ES-SCLC who received GCT had SACT only (34.8%) or SACT and radiotherapy (38.1%). ES-SCLC patients who received non-GCT received radiotherapy only (3.6%). There was a slightly higher proportion of patients with ES-SCLC who received no treatment (14.1%) compared to LS-SCLC (5.2%).

3.3 | Kaplan–Meier Survival Estimates

The overall one-year survival rate for 1766 patients with SCLC was 40% and 23% at 2 years, Figure S2. Median survival for LS-SCLC was 1.8 years and 0.60 (6 months) for ES-SCLC, Figure 1. Patients who had LS-SCLC treated with GCT had a 29% increase in one-year survival and a 27% increase in two-year survival compared to non-GCT treated patients, Figure 1. Patients who had ES-SCLC treated with GCT had a 20% increase in one-year survival and a 7% increase in two-year survival compared to non-GCT patients, Figure 1.

3.4 | Factors Influencing Likelihood of Receiving GCT

The likelihood of receiving GCT was significantly lower with increasing age. Patients aged 70 to 79 years had a 69% lower likelihood of receiving GCT (OR 0.31 [0.15–0.64]) while those aged > 80 years had 86% reduced odds of receiving GCT (OR 0.14 [0.06–0.33]) compared to those aged < 60 years. Renal insufficiency reduced the odds of GCT by 84% (OR 0.16 [0.05–0.56]), and an ECOG score of ≥ 2 reduced the odds of receiving GCT by 63% (OR 0.37 [0.23–0.60]). Patients with ES-SCLC had 10.9 times higher odds of receiving GCT compared to patients with LS-SCLC, Table 2. The area under the curve for the multivariable logistic regression was 0.98, which is considered an excellent model [28].

The results of the landmark logistic regression model, excluding patients that died within 28 days after diagnosis in Table S4, showed those with increasing age, renal insufficiency, poorer ECOG performance status, and ES-SCLC were associated with a lower likelihood of receiving GCT. The model demonstrated strong discrimination with an area under the curve (AUC) of 0.98.

3.5 | Factors Influencing Survival

Factors that were associated with a higher risk of mortality included having an ECOG performance score of ≥ 2 (HR 1.47 [1.22–1.78]) and having ES-SCLC (HR 3.29 [2.67–4.06]). All patients with SCLC treated with GCT had a significantly lower mortality hazard (HR 0.40 [0.30–0.54]) compared to non-GCT (Table 3). The area under the ROC for the multivariable COX regression was 0.7095, which is considered a good model [28].

The landmark COX model, excluding patients that died within 28 days of diagnosis in Table S5, yielded similar findings, with poorer ECOG performance status and ES-SCLC associated with an increased risk of mortality, while receipt of GCT was significantly associated with lower mortality. A notable difference between the standard Cox model and the landmark model was the finding that patients with a respiratory comorbidity had a reduced risk of mortality in the landmark model (HR 0.78, 95% CI: 0.64–0.95). The area under the ROC curve was 0.7225, comparable to that of the standard model.

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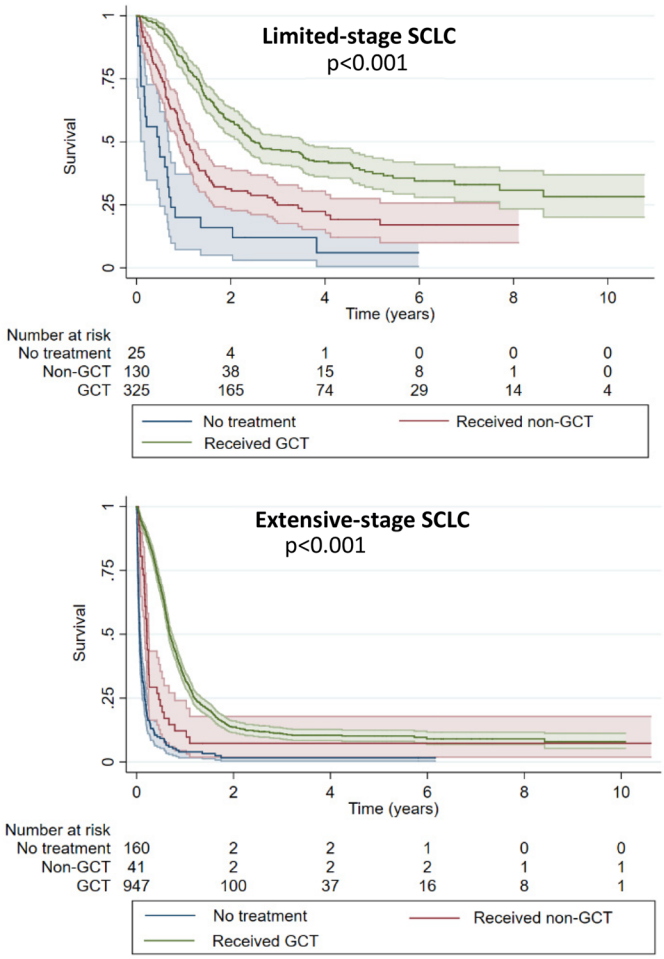

FIGURE 1 | Kaplan-Meir survival curves by cancer stage.

Treatment	1-year survival	2-year survival
Limited stage SCLC		
No treatment	0.20 (0.07-0.37)	0.16 (0.05-0.33)
Non-GCT	0.53 (0.44-0.61)	0.31 (0.23-0.39)
GCT	0.82 (0.77-0.86)	0.58 (0.53-0.64)
Extensive stage SCLC		
No treatment	0.04 (0.02-0.08)	0.02 (0.00-0.05)
Non-GCT	0.12 (0.04-0.24)	0.07 (0.02-0.18)
GCT	0.32 (0.29-0.35)	0.14 (0.11-0.16)

4 | Discussion

In this cohort study of patients with SCLC, 78.1% received GCT, 10.5% received non-GCT, and 11.5% had no treatment. Patients with ES-SCLC were more likely to receive GCT. Predictors associated with a reduced likelihood of receiving GCT included older age, poorer performance status, and renal insufficiency. Poorer performance status and ES-SCLC were also associated with worse survival outcomes. Receiving stage-specific GCT was associated with improved survival, with a 60% reduction in mortality risk compared to those who received non-GCT.

This study is the first of its kind to report the proportion of Australian patients with limited-stage small cell lung cancer (LS-SCLC) who received guideline-concordant treatment (GCT) and the associated impact on survival. Only 25.5% of LS-SCLC patients in our cohort received GCT, meaning nearly three-quarters (74.5%) did not receive the gold standard treatment despite its known survival benefits. This is an important finding that highlights a significant gap in care for patients diagnosed at a potentially curable stage. Previous research in Stage I SCLC found similar results with a significant underuse of surgical resections, despite the established treatment guidelines [29, 30]. The underutilization of GCT in LS-SCLC is concerning and warrants further investigation into the barriers preventing optimal care, which may include patient-related factors, health service capacity limitations, geographical or other barriers to care, or clinical decision-making factors.

In contrast, patients diagnosed with ES-SCLC were more likely to receive GCT, with 74.5% of patients in our cohort receiving this recommended treatment. This is consistent with findings from international studies including a systematic review with over 100 studies showing high adherence to treatment guidelines among patients with ES-SCLC [31]. Similarly, Blom et al. reported that 71.9% of ES-SCLC patients received GCT, though their study did not examine predictors of GCT receipt or its direct effect on survival [14]. While previous research has shown that GCT is associated with improved survival in lung cancer more broadly, these studies did not focus specifically on SCLC [15, 32–34]. Our study helps address this gap by demonstrating that receipt of GCT was significantly associated with improved survival in patients with ES-SCLC and highlighting the importance of treatment adherence in improving outcomes for this patient group.

There are several modifiable factors that clinicians may consider when determining treatment pathways, including older age, ECOG performance status, and whether patients are discussed at an MDM. Elderly patients diagnosed with lung cancer are undertreated or receive more conservative treatment.

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TABLE 2 | Univariable and multivariable logistic regression for receipt of GCT.

	Univariable analysis		Multivariable analysis ($n = 1023$)	
	Odds ratio (95% CI)	***p***	**Odds ratio (95% CI)**	***p***
Patient characteristics				
Age (ref: < 60 years)				
60 to 69 years	0.73 (0.41–1.33)	0.307	0.67 (0.31–1.56)	0.378
70 to 79 years	0.32 (0.19–0.55)	< 0.001	0.31 (0.15–0.64)	0.002
80 years and over	0.19 (0.11–0.36)	< 0.001	0.14 (0.06–0.33)	< 0.001
Male (ref: female)	1.34 (0.97–1.85)	0.073	1.00 (0.64–1.56)	0.996
Regionality of residence (ref: metro)				
Rural/regional area	0.93 (0.66–1.30)	0.667		
Other (state/overseas/unknown)	0.71 (0.29–1.73)	0.450		
ATSI status (ref: non-ATSI)				
Aboriginal/Torres Strait Islander	1.00 (0.23–4.43)	1.00		
Country of birth (ref: Australia)				
Overseas	0.76 (0.54–1.05)	0.098		
Preferred language (ref: English preferred)				
Other language	0.89 (0.49–1.60)	0.692		
Socio-economic status[a] (ref: low SES)				
Medium	1.48 (0.98–2.23)	0.061		
High	1.24 (0.82–1.87)	0.308		
Smoking status (ref: never smoked)				
Ex-smoker	0.45 (0.10–1.91)	0.276		
Current smoker	0.65 (0.15–2.80)	0.565		
Comorbidities				
Diabetes (ref: no diabetes)	0.87 (0.60–1.27)	0.468		
Renal insufficiency (ref: no renal insufficiency)	0.23 (0.10–0.53)	< 0.001	0.16 (0.05–0.56)	0.004
Myocardial infarction (ref: no myocardial infarction)	0.78 (0.52–1.17)	0.234		
Respiratory comorbidity (ref: no respiratory comorbidity)	0.72 (0.51–1.03)	0.073		
Neoplastic comorbidity (ref: no neoplastic comorbidity)	0.77 (0.51–1.15)	0.201		
ECOG status (ref: score < 2)				
Score ≥ 2	0.46 (0.31–0.69)	< 0.001	0.37 (0.23–0.60)	< 0.001
Weight loss (ref: no weight loss)				
Yes	1.36 (0.95–1.95)	0.095		
Cancer characteristics				
Cancer stage (ref: limited disease stage I-III)				
Extensive disease stage IV	9.25 (6.37–13.43)	< 0.001	10.85 (6.44–18.28)	< 0.001

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TABLE 2 | (Continued)

	Univariable analysis		Multivariable analysis ($n = 1023$)	
	Odds ratio (95% CI)	***p***	**Odds ratio (95% CI)**	***p***
Cancer management				
Discussed at MDM[b] (ref: no MDM discussion)	0.59 (0.42–0.83)	0.003	0.83 (0.48–1.44)	0.518
Psychosocial distress screening (ref: no screening)	1.33 (0.95–1.84)	0.093		
Hospital characteristics				
Treating Hospital Regionality (ref: public metro hospital)				
Private metropolitan hospital	0.53 (0.33–0.86)	0.010	0.51 (0.23–1.11)	0.089
Inner regional hospital	1.35 (0.84–2.19)	0.216	1.19 (0.65–2.17)	0.568
Area under the ROC	—	—	0.9760	

[a]Low = IRSAD decile 1 to 3, Medium = IRSAD decile 4 to 7, High = IRSAD decile 8 to 10 (IRSAD = Index of Relative Socio-Economic Advantage and Disadvantage).
[b]Multidisciplinary meeting.

This may be attributed to concerns around treatment tolerability, potential toxicity, lack of geriatric assessment, inappropriate clinical decision-making biases, and the presence of multiple comorbidities [34–38]. Our study supports this disparity, as patients who were treated with GCT had a younger mean age (67.26 ± 9.74 years) compared to patients that received non-GCT treatment (72.52 ± 8.48 years) and no treatment (74.25 ± 9.85 years).

Furthermore, the logistic regression showed that patients aged > 70 years were 69% less likely to receive GCT and those > 80 were 86% less likely to receive GCT compared with those who were < 60 years. Given the median age for diagnosis of SCLC is around 69 years of age, this means that a large proportion of the patient population may be missing out on treatment that can improve quality of life and improve overall survival. Recent evidence suggests that older patients are capable of both tolerating and benefiting from receiving GCT [39, 40]. Kawaguchi et al. demonstrated that patients aged 80 and older who received chemotherapy had a significant survival benefit [39]. Similarly, Lindqvist et al. found adherence to treatment guidelines in older patients led to improved overall survival [34]. These findings underscore the importance of careful assessment of older patients and highlight a possible need for better integration of geriatric assessments into treatment planning.

EOCG performance status is another important determinant of SCLC survival [41]. Our study found that 22.8% of patients with an ECOG of ≥ 2 received GCT and that these patients had 63% reduced odds of receiving GCT. Despite its importance, few studies have thoroughly examined the impact of ECOG status on treatment decisions and survival outcomes in SCLC. A recent study involving 3150 patients with extensive-stage SCLC found that those who survived beyond 24 months were significantly more likely to have an ECOG score < 2 [42]. This finding is consistent with our results where survival was higher among patients with a better performance status. Our findings also reflect trends observed in non-small cell lung cancer (NSCLC), where patients with ECOG ≥ 2 are less likely to receive treatment and generally have poorer prognoses [11, 43–45]. However, it has been suggested that patients with poorer performance status might still tolerate treatment, indicating the need for further research, particularly in the SCLC population [44, 46]. This is particularly important when a patient's poor ECOG status is mainly due to the extent of their disease at diagnosis, as it may improve with appropriate treatment—unlike when it is caused by broader, more complex or multifactorial health issues that are harder to reverse.

Overall, only 55% of patients in this cohort were referred to an MDM following diagnosis. Among them, 57.5% of those who received GCT had an MDM, compared to 69.6% of those who received non-GCT. The Australian Optimal Care Pathway for patients with lung cancer recommends that all patients should be discussed at an MDM [47]. Additionally, several studies have shown that discussion at an MDM can have a positive impact on survival as well as a patient's quality of life and reduce the time from diagnosis to treatment [36, 48–50]. A previous study in a Victorian cohort of NSCLC patients found that 72% of those receiving GCT had an MDM, compared to 65% of those receiving non-GCT [11]. Interestingly, our analysis found no significant difference in survival between patients who were and were not discussed at an MDM, in both the standard and landmark COX models. As a real-world clinical registry, the VLCR collects data from multiple centers through trained data collectors using standardized data dictionaries to promote consistency. Nevertheless, inconsistent reporting for MDM may exist across hospitals. Although MDM discussion is recommended, the registry reflects actual clinical practice, including such variations. The current analysis did not explore reasons behind the lack of survival difference between patients discussed at MDM and those who were not. Further research with more complete MDM data in a larger SCLC cohort is needed to clarify the role of MDM in SCLC management and its impact on survival. Additionally, further investigations are needed to determine why a lower percentage of SCLC patients received an MDM compared to those with NSCLC in the same geographic region.

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TABLE 3 | Univariable and multivariable COX regression for predictors of survival.

	Univariable analysis		Multivariable analysis ($n = 907$)	
	Hazard ratio (95% CI)	***p***	**Hazard ratio (95% CI)**	***p***
Patient characteristics				
Age (ref: < 60 years)				
60 to 69 years	1.08 (0.93–1.26)	0.313	1.10 (0.88–1.37)	0.400
70 to 79 years	1.29 (1.11–1.50)	0.001	1.10 (0.88–1.38)	0.402
80 years and over	2.00 (1.67–2.40)	< 0.001	1.28 (0.94–1.73)	0.113
Male (ref: female)	1.17 (1.05–1.30)	0.003	1.09 (0.93–1.28)	0.298
Regionality of residence (ref: metro)				
Rural/regional area	0.97 (0.87–1.08)	0.550	0.933 (0.78–1.11)	0.443
Other (state/overseas/unknown)	0.48 (0.33–0.71)	< 0.001	0.16 (0.07–0.40)	< 0.001
ATSI status (ref: non-ATSI)				
Aboriginal/Torres Strait Islander	0.72 (0.43–1.20)	0.210		
Continent of birth (ref: Australia)				
Born Overseas	1.05 (0.94–1.17)	0.369		
Preferred language (ref: English preferred)				
Other language	0.98 (0.81–1.18)	0.797		
Socio-economic status[a] (ref: low SES)				
Medium	1.05 (0.92–1.20)	0.467		
High	1.07 (0.93–1.23)	0.329		
Smoking status (ref: never smoked)				
Ex-smoker	1.34 (0.90–1.98)	0.147		
Current smoker	1.23 (0.89–1.82)	0.294		
Comorbidities				
Diabetes (ref: no diabetes)	1.11 (0.98–1.26)	0.097		
Renal insufficiency (ref: no renal insufficiency)	2.28 (1.69–3.09)	< 0.001	1.37 (0.73–2.60)	0.324
Myocardial infarction (ref: no myocardial infarction)	1.05 (0.92–1.21)	0.472		
Respiratory comorbidity (ref: no respiratory comorbidity)	0.94 (0.83–1.07)	0.344		
Neoplastic comorbidity (ref: no neoplastic comorbidity)	1.15 (1.00–1.32)	0.052		
ECOG status (ref: score < 2)				
Score ≥ 2	1.85 (1.61–2.13)	< 0.001	1.47 (1.22–1.78)	< 0.001
Weight loss (ref: no weight loss)				
Yes	1.28 (1.14–1.45)	< 0.001	1.07 (0.91–1.23)	0.438
Cancer characteristics				
Cancer stage (ref: limited disease stage I-III)				

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TABLE 3 | (Continued)

	Univariable analysis		Multivariable analysis ($n = 907$)	
	Hazard ratio (95% CI)	***p***	**Hazard ratio (95% CI)**	***p***
Extensive stage disease IV	2.74 (2.40–3.12)	< 0.001	3.29 (2.67–4.06)	< 0.001
Treatment (ref: receiving non-GCT)				
Receiving GCT	0.19 (0.16–0.23)	< 0.001	0.40 (0.30–0.54)	< 0.001
Cancer management				
Discussed at MDM[b] (ref: no MDM discussion)	0.70 (0.63–0.77)	< 0.001	0.96 (0.81–1.14)	0.610
Psychosocial distress screening (ref: no screening)	0.72 (0.65–0.81)	< 0.001	1.07 (0.91–1.26)	0.384
Hospital characteristics				
Hospital Regionality (ref: public metro hospital)				
Private metropolitan hospital	0.94 (0.79–1.12)	0.498		
Inner regional hospital	1.00 (0.87–1.14)	0.990		
Area under ROC	/	/	0.7095	

[a]Low = IRSAD decile 1–3, Medium = IRSAD decile 4–7, High = IRSAD decile 8–10 (IRSAD = Index of Relative Socio-Economic Advantage and Disadvantage).
[b]Multidisciplinary meeting.

4.1 | Strengths

The VLCR collects data on all consecutive patients newly diagnosed with lung cancer at participating hospitals across Victoria, ensuring broad population coverage and minimizing selection bias. One major strength of this study is the large cohort size, with data from over 1700 patients diagnosed with SCLC, making it one of the most comprehensive and representative datasets in Australia.

The registry's web-based data capture system uses standardized data dictionaries and harmonized coding across all participating sites, promotes consistency in data collection, and minimizes information and measurement bias. The VLCR also maintains a high level of data completeness for most clinical and demographic variables, further strengthening the reliability of the findings. Additionally, missing data were addressed using multiple imputation techniques, improving the robustness of the analyses by minimizing bias associated with incomplete variables. To further validate the findings, a landmark sensitivity analysis was conducted, which confirmed the consistency of key associations between receipt of GCT and survival outcomes. This additional methodological approach supports the reliability and generalizability of the study's conclusions.

4.2 | Limitations

VLCR outcomes are specific to Victorian patients and therefore may not be generalizable Australia wide and internationally. Additionally, as VLCR data is sourced from hospital records, it may not capture events occurring after hospital discharge, describing disease recurrence and second-line treatments. Additionally, data collection occurs at a single time point, and thus it may not capture subsequent radiotherapy or SACT treatments. Further, total dose, fractionation of thoracic radiotherapy, or use of prophylactic cranial irradiation was not collected.

As a clinical quality registry, the VLCR collects mainly clinical data and does not capture patient perceptions, preferences, or treatment refusals. This limits understanding of factors contributing to treatment gaps. Future research including patient-reported preference data is needed to address this. The VLCR does not capture lifestyle factors such as physical activity, alcohol consumption, educational status, or other health behaviors that may influence receiving GCT. It is important to acknowledge that the broad definition of GCT used in this study is a limitation. The definition of GCT continues to evolve, with targeted therapies and immunotherapies becoming funded first-line treatments for ES-SCLC since 2019. Moving forward, GCT definitions will need to adapt accordingly. The registry does not capture the rationale behind treatment choices. Future studies should include more detailed treatment data including reasons for deviation from the guidelines to better understand the clinical decision-making process. Finally, this study looks at data across a period of 12 years (2011–2013), during which diagnostic methods and patterns of care have evolved. As a result, temporal changes in clinical practice may not be fully captured in the analysis.

5 | Conclusion

This study demonstrates the importance of guideline-concordant treatment in improving survival for SCLC patients, framing an important measure of quality of lung cancer care. One of the most significant findings was that only 25.5% of

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patients with LS-SCLC (considered a potentially curable setting) received GCT compared to 74.5% of patients with ES-SCLC receiving GCT. This stark gap in evidence-based care highlights an urgent need to better understand barriers to optimal treatment in this population. While patients with ES-SCLC were more likely to receive GCT, our findings underscore the need to ensure that more patients, including the elderly and those with lower performance status, are not excluded from optimal care. Greater attention to modifiable factors such as multidisciplinary discussion and integration of geriatric assessment may help bridge these treatment gaps and improve outcomes. Future studies should also examine time to diagnosis and time to treatment, as these may significantly influence care quality and survival outcomes.

Author Contributions

S.T., R.G.S., B.B. conceptualization. S.T. Data curation. S.T. Formal analysis. Nil Funding acquisition. S.T., B.B., M.N.K. Investigation. S.T., B.B., M.N.K., S.H. Methodology. S.T. Project administration. S.T. Resources Software. B.B., M.N.K., R.G.S., S.H. Supervision. B.B., M.N.K., S.H. Validation. S.T., B.B., R.G.S. Visualization. S.T. Writing – original draft. B.B., R.G.S., M.N.K., J.Z., P.A., R.B., M.C., M.C., I.O., P.P., G.R., E.S., K.S., C.U., G.W., J.T., S.P., T.J., J.Z., W.F., S.H. Writing – review and editing.

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Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The data underlying this article are sourced from the Victorian Lung Cancer Registry and are available upon reasonable request, subject to governance and ethics approval.

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Supporting Information

Additional supporting information can be found online in the Supporting Information section. **Data S1:** Supporting Information.

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